Internet of Things for Long Distance Parent-Adult Child Relationships

Patil, Bhagyashree

Award date:
2018

Awarding institution:
University of Bath

Internet of Things for Long Distance Parent-Adult Child Relationships

Bhagyashree Patil

A thesis submitted for the degree of Doctor of Philosophy
University of Bath
Department of Psychology
April 2018

Acknowledgements

Firstly, I would like to thank my supervisors Prof Danae Stanton Fraser, Dr Jeff Gavin and Clare Reddington for their support and guidance and for their encouragement to undertake this research which was challenging yet thoroughly enjoyable. I am incredibly grateful to all my participants who took part in my studies, without them I could not have completed my PhD.

I would like to thank my family for their support, especially Aai and Pappa, and my brother Rutvik for their support, understanding and encouragement. Also, I am hugely grateful to Adam for his support, for listening to me complain, believing in me and designing my posters to get participants. Another special mention goes to Ryan, the one I enjoyed discussing relevant literature to my research.

I am incredibly grateful to friends that proofread my thesis, especially Andrew who was there to help every time I requested. Also, I would like to thank all the wonderful friends I made along the way, who shared in the ups and downs and made this time extra special by being my family away from home (Harina, Eleanna, Elaine, Niamh, Elisa, Josie, Claire, Dima, Filipa, Alaa, Holly, Geoff, Ben et al!) As well as those from elsewhere (Prachi, Behzad). I would also like to thank members of CREATE lab and Watershed for having me as a member of their team.

Finally, I would like to thank those people that I do not know names of, a few Baristas who made perfect coffees, strangers who smiled at me for no reason and the ones that spread joy everywhere with their little acts of kindness, all of which brought me so much joy.

Preface

I lived with my family in India before I left to pursue my ambitions to study abroad a few years ago. Finding myself alone in a foreign land, I found communication with my parents became very important, however the time difference, cost of international calling as well as shortcomings with the available technology itself made it challenging. I was not just me, my parents, especially my mother with whom I am very close, also found the new situation upsetting.

My mother worried if I was okay and expected me to get in touch with her to let her know how I was and that everything was fine. However, as a PhD student, I found it difficult to call her regularly because of my busy schedule and the time difference between the countries. Neither my mother nor my father used smartphone at the time and it was very difficult for me to stay connected with them. In effort to bridge this technology gap, I got my mother a Smartphone, made her an email account, a WhatsApp account, a Facebook account and a Skype account. Yet, I remember feeling frustrated with her as she would not make efforts to learn how to use these technologies out of fear that they were very difficult to use.

Even though both of my parents now use Smartphones and communication has become much better, we still find it hard to maintain contact as much as we desire. We have to arrange a time when we are free and find a quiet place to talk or video chat. In addition to this, my parents don't want to interrupt me if I'm busy; therefore, despite of the new avenues available via Smartphone, we may not communicate with each other for long stretches of time. As a way of still feeling connected to me despite the time between physical communications, my mother checks my "last seen" status on WhatsApp. She sometimes asks me if I was awake till late night and it's not good for health therefore, I should be going to bed early! This can be a little irritating, yet it also feels nice as I feel loved and cared for.

In particularly busy parts of my life, I found that my parents were making less contact with me with fear of not distracting me from my work. Although I was busy, I still wanted to keep in contact with them as I needed their emotional support through this tough time. Less contact from them made me feel less connected and after a few days started making me feel less close to them which also made me feel very lonely. These experiences have highlighted for me the importance of maintaining connectedness with my parents for my happiness and overall psychological well-being.

My experiences have given me first-hand insight into the needs and experiences of geographically distant families, making this research important to me on a personal level. Existing technologies have the power to connect people over distance, but they may not do so in a way that is sensitive to the nuanced texture of the relationships that exist between parents and adult children. I hope that my work on this thesis - investigating the potential for IoT technologies to support lightweight connections - will go some way to resolving this problem, supporting and maintaining the desire for connectedness in long distance parent-adult child relationships.

Publications

Part of this work in Chapter 3 and Chapter 4 was presented in the following workshop paper:

- Patil, B., Kelly, R., Fraser, D. S., Gavin, J., & Reddington, C. (2016). Supporting distant familial relationships with the internet of things. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct* (pp. 661-665). ACM.

Summaries of this work were presented at the following doctoral consortia:

- Patil, B. (2017). Connected Objects to Support Parents and Their Adult Children. In: *INTERACT*. Mumbai: Springer.

Other collaborative work closely related to this thesis was published in following conference:

- Kelly, R., Gooch, D., Patil, B., & Watts, L. (2017). Demanding by design: Supporting effortful communication practices in close personal relationships. In *The 20th ACM Conference on Computer-Supported Cooperative Work and Social Computing*.

Abstract

People are increasingly moving away from their families for work, studies or simply to start an independent life. Yet people in close interpersonal relationships may wish to stay connected with their families to maintain closeness in their relationship. Parent-adult children relationships are especially important as they can be the most long lasting and stable relationships in a person's life and have an effect on overall happiness and psychological wellbeing. Researchers in Human-Computer Interaction (HCI) have recognized the need to support distant family relationships and there have been a large number of devices created to support close interpersonal relationships. However, previous studies have focused on designing technologies to connect friends, lovers or families in general, yet different relationships may have different needs and something that is desirable for a particular relationship may not be desirable for others. Limited research has been conducted focusing on supporting parent-adult children relationships nor do these studies focus on supporting closeness and connectedness in distant relationships. The fast spreading use of Internet of Things (IoT) technologies provides opportunities for connecting people over distance however much of the current research focuses on tackling technical issues around IoT and there is not much research exploring the role of the user and their experiences with the IoT or how IoT technologies could be designed to connect people over distance.

This thesis evaluates whether novel technologies designed using IoT technologies can support distant parent-adult children relationships. This is achieved by evaluating their current communication practices and deploying two different IoT artefacts in the wild to understand how these technologies integrate into routine communication. Social presence, connectedness and closeness are used as the main theoretical constructs through which support for parent-adult child relationships are addressed. The two main research questions are:
1. Can the Internet of Things (IoT) technologies support closeness and connectedness in distant parent-adult child relationships?
2. What value does connectedness have for this particular relationship and how does that relate to closeness in the relationship?

There are four studies in this thesis; two longitudinal field studies described in Chapter 3 and 5 in which we design and evaluate two different artefacts and two online survey studies described in Chapter 4 that explores the association between technology use, connectedness and closeness in parent-adult child relationships. The two longitudinal studies explore can awareness systems and expressive systems support social presence, connectedness and closeness in this relationship. This is carried out through the design and evaluation of two artefacts: *SmartLamp* and *ConnectedJewellery*. To evaluate these two systems, we chose a mixed methods

approach using longitudinal studies around diary based self-report activity from pairs of parents and their adult children. The mixed method research involved collecting, analysing and integrating quantitative as well as qualitative data. Quantitative data of social presence, connectedness and closeness were gathered using validated and reliable questionnaires. Qualitative data about communication routines of participants and their experiences of using technologies were gathered from interviews and open ended questions in questionnaires. The two online survey studies collected predominantly quantitative data from adult children and parents that had adult children however also employed open-ended questionnaires to gather qualitative data. The participants of the two online questionnaire studies were not necessarily related to each other.

This thesis concludes with a discussion of how the results of these studies are of relevance to researchers and designers interested in supporting long distance parent-adult child relationships. This thesis makes some empirical and theoretical contributions to the psychology as well as the HCI field. There are three main empirical findings, firstly, awareness provided by artefacts embedded in surroundings and expressive phatic signals exchanged using wearables both can elicit positive feelings of closeness and connectedness. Secondly, expressivity might be a better strategy than awareness for supporting emotional connection between parent-adult child relationships. Thirdly, connectedness might be the more suitable concept than social presence for evaluating communication technologies designed for close interpersonal relationships.

There are three main theoretical findings. Firstly, this thesis contributes to the area of communication studies by providing an understanding of how parents and adult children use ICT to maintain relationships over distance. Secondly, it gives an understanding of desired connectedness in this relationship and that increasing the feeling of connectedness can have a longer-term impact on parent-adult child relationships through increasing the feelings of closeness towards one another. Finally, it adds to the understanding of the needs and dynamics of this relationship. Given the scarcity of devices aimed at supporting parent-adult child relationships, this thesis lays the groundwork for further research in this area for researchers interested in extending these findings by exploring other strategies to design technologies to support this relationship.

Table of contents

List of Tables

Table of Figures

1 Chapter: Introduction

The world is becoming more globalised, and people are moving away from their loved ones for a variety of reasons. Long distance parent-adult child relationships are more common as children leave home for education, work or simply to start an independent life. The feeling of closeness plays a very important role in people's lives and has an impact on their well-being. Distant families can feel lonely and lack feelings of emotional intimacy, closeness and connectedness due to distance(Hill & Dunbar, 2003; Schaefer & Olson, 1981). Closeness refers to high interdependence within the relationship (Mashek & Aron, 2004) and connectedness refers to the feeling of 'being in touch'(Rettie, 2003). With the help of technology, it is possible to establish some form of connection or closeness using, for example, video chat, instant messaging, and email (Firmin, Firmin, & Lorenzen, 2006). These communication mechanisms alone are not sufficient to create emotional intimacy in distant relationships as they are focused on the transmission of explicit information (Hassenzahl, Heidecker, Eckoldt, Diefenbach, & Hillmann, 2012; Kuwabara, Watanabe, Ohguro, Itoh, & Maeda, 2002). People report feeling disturbed by constant notifications on their mobile phones (Tsujita, Tsukada, & Siio, 2009). Also, most devices are not specifically designed for creating connectedness and closeness between family members. Thus, there is an opportunity to find new ways to create presence, support connectedness and closeness over geographical distance.

Researchers in Human-Computer Interaction have long recognised the need to support distant family relationships, and there have been a large number of devices created to support close interpersonal relationships. Previous studies have focused on designing technologies to connect lovers (Gooch & Watts, 2012; Kaye, 2006) or families (Harboe, Massey, Metcalf, Wheatley, & Romano, 2008; Truong, Richter, Hayes, & Abowd, 2004). However, different relationships may have different needs, and something that is desirable for a particular relationship may not be desirable for others. The parent-adult child relationship is especially important as this is often the longest sharing relationship in a person's life and has an impact on psychological well-being (Lye, 1996). However, there has been little research on parents and their adult children to explore how novel technologies could support them. A few studies that do look at the parent and adult children do not carry out in-depth evaluations neither do they explore if technologies can support social presence, connectedness or closeness within this relationship (Keller, van der Hoog, & Stappers, 2004; Soro, Brereton, & Roe, 2015).

There are almost 23 billion wirelessly connected devices, also referred to as the Internet of Things (IoT) on the market today; with over 75 billion devices expected by 2025 (IHS, 2018). These devices offer applications in various areas such healthcare, transportation, intelligent homes and provide opportunities to appropriate them to design novel systems that can connect people living away from each other. This thesis aims to investigate if, and how, IoT devices that are in our surroundings

or on our bodies (wearable technology) can create social presence or connectedness and how this might affect closeness in distant relationships.

This thesis explores how novel technologies can support distant parent-adult children by analysing their current practices of maintaining a relationship over distance through surveys as well as designing and deploying two different artefacts using off-the-shelf IoT technologies in the wild. The thesis comprises of three studies, two longitudinal in-the-wild studies and an online survey study. To investigate how novel technologies can create social presence and connectedness respectively, we have designed two novel systems *SmartLamp* and *ConnectedJewellery* by using commercially available IoT objects as components to design these systems. To evaluate these two systems, we chose a mixed methods approach using longitudinal studies around diary based self-report activity from pairs of parent-adult children. The two main research questions addressed were:

1. Can Internet of Things (IoT) technologies support closeness and connectedness in distant parent-adult child relationships?
2. What value does connectedness have for this particular relationship and how does that relate to closeness in the relationship?

The first question is the main motivation behind this thesis. This question is explored by understanding the routine communication practices of parents and their adult children and then by designing two novel design solutions using off-the-shelf IoT components to support social presence, connectedness and closeness within this relationship (See Table 1). Two studies employ different design strategies: awareness and expressiveness. In the literature, the devices that allow sharing of awareness or presence information are termed awareness devices and the devices that allow sending/receiving affective messages, such as ‘thinking of you’, ‘I love you’, are termed expressive devices (Hassenzahl et al., 2012). The awareness design strategy was explored in the first study, in which a system called *SmartLamp* was designed to create awareness of a distant adult child in their parents’ lives. It used a connected lamp situated in a parent’s home that is switched on or off when their adult child arrives or leaves a particular place. The second design solution is called *ConnectJewellery* which used connected rings or bracelets to express a feeling of ‘thinking of you’ to one another.

The first research question in this thesis explores how novel technologies can be designed to support closeness and connectedness in parent-adult children relationships. However, there is little evidence whether parents and their adult children desire connectedness and what value the connectedness has for this particular relationship. Therefore, the second research question seeks to explore whether there is a link between connectedness and closeness. Connectedness is a feeling of ‘being in touch’. It is one of the three motivating principles that promote social relationships (Rettie, 2003). Limited research has been carried out on feelings

of connectedness between parents and adult children in the context of communication technologies. The second study, using an online survey explores the association between connectedness and closeness. The study explores the issue from two perspectives: that of adult children and that of parents of adult children by means of two online surveys. The study examines the association between desired connectedness, actual connectedness, and frequency of contact, the number of technologies used and relationship closeness and satisfaction.

Table 1

Description of the Two Design Artefacts and Their Evaluation Study

Name of the device	***SmartLamp*: Study 1**	***ConnectJewellery*: Study 3**
Design strategy used:	Awareness	Expressiveness
Type of system:	Asymmetrical (Only parents had the lamp)	Symmetric (Both parents and their adult children used either a ring or a bracelet)
Type of signals conveyed (Implicit/Explicit):	Implicitly or automatically conveyed presence	Explicit action to express 'Thinking of you.'
Device placement:	The peripheral environment of the user- Home or office	Wearable device
Type of sensory information:	Visual	Tactile and Visual
Synchronicity:	Synchronous	Synchronous

1.1 Thesis structure

A more detailed description of the structure of the thesis and the each of the chapters are outlined below:

Chapter 1 (Introduction): This Chapter provides some background information relating to the thesis, regarding both the content and the structure. The Chapter also outlines the rationale for undertaking this research and the chosen methodology for this thesis.

Chapter 2 (Literature review): This Chapter presents a critical review of the literature surrounding parent-adult child relationships, communication, connectedness, social presence, closeness and the devices that have been designed to support close interpersonal relationships. We also discuss the Internet of Things, their applications, some of the issues and how they could be exploited to connect people over distance. The literature review provides a background to the subsequent studies and highlights some of the existing gaps in the literature which this thesis aims to address. It also concludes with the overarching research questions that will be explored in this thesis.

Chapter 3 (Study 1): This Chapter consists of a study that explores if, and how, awareness provided by an artefact embedded in a user's environment can support social presence and closeness in parent-adult child relationships. We designed a system called *SmartLamp* by using commercially available IoT smart switches, and small electric lamps that could be plugged-in to these switches to connect to the internet. These lamps, placed at a parent's home, would switch on or off automatically when their adult-child arrived at or left a certain place. It was a synchronous, asymmetric system where only parents had the lamps that were connected to their adult child's mobile phone using GPS. We carried out an in-the-wild evaluation of *SmartLamp* over four weeks with six different parent-adult children dyads living in the UK but in different cities. We used a mixed method approach using diary studies to explore if the use of *SmartLamp* supports social presence and closeness in distant parent-adult children relationship. We collected quantitative data about social presence and closeness and qualitative data about communication and experiences with the *SmartLamp.* It was found that parents worry about their adult children's well-being and desire more contact with them yet they may hesitate to do so as they do not want to disturb their adult children. Adult children also seem to desire more contact yet also want to maintain some distance. Adult children also may find it difficult to keep in touch because of busy lives and seemed to carry a feeling of guilt for not keeping enough contact as much as their parents' desire. The key findings were that awareness provided by the lamp of adult child's arrival, and departure elicited positive feelings of closeness between the dyads of parent-adult children. The lamp had several affective benefits to the relationship such as awareness of routine, availability, reassurance of well-being, and

increased frequency of contact between dyad. There were some costs of using the lamp such as worries if the lamp didn't switch on and intrusiveness concern of parents. However, these concerns were not echoed by their adult children. The findings of this study, about differences between desired connectedness of parents and adult children inspired the design of our next study, an online survey that investigated if these findings applied to the wider population. Also, these findings provided inspiration for the design of a novel artefact to support this relationship called *ConnectJewellery* documented in Chapter five.

Chapter 4 (Study 2): This Chapter reports a study using two online questionnaires, which investigate how current communication technologies are used by parents and adult children to maintain their relationships, if they desire connectedness and what value connectedness has for this relationship. The first part of this study collected data from adult children and the second part collected data from parents. These groups were not related to one another however they allowed us to explore the issue from two perspectives. This study addresses the types of technologies currently used, the total number of technologies used and the frequency of contact by adult children and parents based on relationship type, age, and distance of the adult child. It also explores if they desired connectedness more than they actually have. The study makes use of correlational analyses to explore relationships, as well as a comparison of means to establish differences between desired and actual connectedness, closeness, and relationship satisfaction. It was found that variations in technology use were linked to the relationship type (gender), the living locations (distance) and the age of users. These were driven by the varying desirability of ease of use, reliability and monitory costs of using the technologies between the different users. Additionally, it was found that the desired connectedness of parent and adult children is significantly higher than their actual connectedness and parents' desired connectedness is significantly higher than adult children's desired connectedness. Also, it was found that the total number of technologies used, connectedness, closeness and relationship satisfaction reported by adult children to both parents and reported by mothers to their adult children were positively correlated. No association was found between these variables reported by fathers.

Chapter 5 (Study 3): This Chapter presents a further field study which is informed by the findings of the previous chapters. This study explores how expressive messages 'thinking of you' sent and received via jewellery could support connectedness and closeness in parent-adult child relationships. We designed a system called *ConnectJewellery* by using commercially available smart rings and bracelets. It was a synchronous, symmetrical system where both parent and adult children had a ring or bracelet. They could use the system to send 'thinking of you' messages to each other using the virtual button on their mobile phone, and their jewellery would vibrate and flash a small light when they received these messages. We evaluated *ConnectJewellery* system by comparing it to *ConnectText* where the same messages were received on a mobile phone instead of jewellery. We carried out a four-week

field study using a mixed method approach to explore if the use of *ConnectJewellery* supports connectedness and closeness in distant parent-adult child relationships. The key findings were that *ConnectJewellery* supported better connectedness than *ConnectText* and both *Connect* systems supported higher connectedness compared to using only traditional technologies to communicate. Additionally, it was found that *ConnectJewellery* had higher affective benefits than *ConnectText* and both *Connect* systems had low affective costs which are often associated with communication technologies. Using *Connect* systems elicited positive feelings of emotional connection between the dyad. Using *ConnectJewellery* also provided parents with the reassurance of the well-being of their adult children and reduced the feeling of guilt often carried by adult children for not maintaining enough contact with their parents.

Chapter 6 (Discussion): This Chapter brings together the results and general findings from all three studies of this thesis. The empirical findings are discussed in terms of the design space and theoretical findings around parent-adult child relationship that contribute to the psychology and HCI literature. We also present some of the design implications that can be employed by researchers and designers to design novel technologies to support parent-adult child relationships as well as other close interpersonal relationships. Finally, we discuss some of the limitations and areas of future research.

1.2 Methodology

All three studies in this thesis use a mixed method approach. We collect qualitative and quantitative data from diary studies, questionnaires and interviews. Study 1 (Chapter 3) and Study 3 (Chapter 5) are field studies lasting for four to six weeks respectively with dyads of parents and their adult children. Study 2 (Chapter 4) comprises of two online questionnaires, one that collected data from adult children and one from parents which were not necessarily related to one another. Quantitative data of social presence, connectedness and closeness were gathered using validated questionnaires. Qualitative data from interviews and open-ended questionnaires was gathered to understand the communication routines of participants and their experiences of using our systems.

The reason for using mixed method approaches was they provides in-depth knowledge using qualitative data from interviews/open-ended questions as well as a broad overview using quantitative data from online surveys/questionnaires (Lazar, Feng, & Hochheiser, 2017). The quantitative data in itself is not meaningfully able to provide us with enough information about the user experiences and qualitative data gave us more detailed information about the context of the experience. Also, the use of mixed methods allows the researcher to triangulate the data by using a combination of methods to evaluate the same social phenomenon (Jick, 1979). It has

been argued triangulation also serves to validate and verify results arising from different research methods, for example by supplementing qualitative research findings through the application of statistical methods (Tashakkori & Teddlie, 2010). Therefore, a mixed-methods approach supports the internal and external validity of the results (Jick, 1979).

During the two field studies (see Chapter 3 and Chapter 5) we collected data before, during and after participants used our systems. This was to understand and compare the effect of using our design solutions on the relationship of the participants. The reason for conducting field studies was that the deployment of our systems in the real world rather than in the lab enabled more naturalistic data collection and minimized unwanted influences due to the unfamiliar setting of labs. A lab study would not have allowed us to understand how these systems are used in participants' daily routines as a lab can be too artificial to reflect true communication practices (Lazar et al., 2017).

The online survey study (see Chapter 4) collected data from parents and adult children which were not necessarily related to each other. This study predominantly gathered quantitative data however also employed open-ended questionnaires to gather qualitative data. The reason for conducting online surveys was it allowed for the gathering of a greater amount of data from a wider ranging audience and provided a broad overview of the phenomena- connectedness and closeness. Large-scale data also provides greater statistical reliability and generalizability (Wright, 2005).

We collected self-report data from all three studies. Study 3 (Chapter 5) also collected system data. The reason for collecting self-report data was because we were interested in subjective user experience with technologies and their attitudes and feelings rather than just a number of communication activities. It is also impossible to measure connectedness, closeness and social presence using physiological measures. Hence most previous studies evaluating user experiences with novel technologies also support this position and collect self-report data from participants (Hassenzahl et al., 2012; Yarosh, Markopoulos, & Abowd, 2014).

None of these data collection techniques are without flaws. The benefits and flaws of these techniques are well known see (Lazar et al., 2017). Being aware of these flaws, enables these techniques to still be effectively employed. As mentioned earlier, by using a range of techniques to study a single issue (such as the diary studies and questionnaire used in Chapter 4 and Chapter 5) allows the triangulation of data to ensure that our analyses and conclusions are not embrittled by the flaws of a single technique.

1.3 Conclusion

This introduction presents an overview of the thesis and the methods used. Furthermore, it provides justification for the use of a mixed method approach to address the aims of the thesis. Finally, this introduction illustrates how the logical progression of the body of research presented within the following chapters forms a coherent argument that answers the research questions presented.

The next chapter reviews the existing research in psychology around parent-adult child relationships, social presence, connectedness and closeness as well as the human-computer interaction literature around technologies designed so far to support distant relationships.

2 Chapter: Literature review

In order to provide a suitable background for this thesis, we reviewed past literature in the fields of psychology, Human-Computer Interaction (HCI) and Computer Supported Cooperative Work (CSCW). This Chapter critically evaluates previous psychology literature on close interpersonal relationships, with a focus on long-distance parent-adult child relationships. We then define and discuss phenomenological concepts used in this thesis such as social presence, connectedness and closeness and the applicability of these variables for evaluation of communication technologies. We then move on to discuss past literature in HCI and CSCW around artefacts designed to support long-distance relationships. We then define and discuss the Internet of Things (IoT) and their potential to support long-distance relationships. The Chapter addresses the gaps in the current literature in the field of connectedness, IoT technologies and artefacts to support parent-adult child relationships prior to their exploration in subsequent chapters.

2.1 Introduction

This thesis examines how the relationship between parents and their adult children who live separately can be supported through the design of connectedness-oriented communication technologies using off-the-shelf IoT products. This literature review argues the importance of studying distant parent-adult child relationships. It firstly underlines the prevalence and significance of this relationship type by considering the current research in this area. Secondly, it brings the light the many gaps in our understanding of this relationship type with a particular emphasis on how parents and their adult children maintain a sense of connectedness and closeness over distance and the growing role ICT has in this area.

With the importance of studying parent-adult child relationships and their ICT usage established, the concepts of social presence, connectedness and closeness are introduced, and a justification for their use in evaluating novel communication technologies is provided. We then discuss the current developments in ICT and the current efforts of the HCI community to enhance parent-adult child relationships. We discuss methodological considerations and challenges with studying parent-adult child relationships. We finally focus on the exciting area Internet of Things (IoT) technologies and the untapped potential they provide to connect distant relationships. This literature review provides a firm foundation which informed the development of the research questions presented at the end of this chapter. These questions gave us a clear framework on which to study the topic of this thesis.

2.2 Close interpersonal relationships

The social group we form in our lives can be categorized into primary and secondary groups (Huijnen, IJsselsteijn, Markopoulos, & de Ruyter, 2004). Primary groups consist of small, supportive groups which include families, close friends, romantic partners and emotionally close people including peers and neighbours. The secondary groups ‘‘are larger and more formally organized and tend to be shorter in duration and less emotionally involving than primary groups.’’ (Huijnen et al., 2004, p. 41). Importantly this implies there is a degree of difference between types of relationships based on the grouping of contacts and the categorization of contacts is important. People share a close relationship with a primary group of people, and it has been reported that these relationships are one of the main sources of happiness in people’s lives, therefore, they are important to be studied (Kubacka, Finkenauer, Rusbult, & Keijsers, 2011)

The frequency of contact and the intimacy of the relationship are the two main factors that determine how relationships are assigned to primary or secondary groups. It has been shown that the frequency of contact is dependent on emotional closeness as well as physical distance between people. Studies have found that “the time since last contact increases as distance to the individual increases, decreases as emotional closeness increases" (Hill & Dunbar, 2003, p. 59). Although this is not constant across culture, studies investigating the link between frequency of contact and relationships has shown a negative association between frequency of contact and geographical distance (Hank, 2007) showing the significant impact of distance on relationships. As we are primarily focused on relationships separated by distance, this provides some initial evidence that distance does have an impact on communication behaviours within a relationship.

Studies carried out by Hindus et al. (2001), and Markopoulos et al. (2005) show that people prefer staying connected with primary groups, especially when they are geographically separated. Previous research carried out on communication technologies has also found that “most participants have a select group of people that they feel they should always be available for" (Chen, Forlizzi, & Jennings, 2006, p. 371). Research shows that people report more positive feelings if they are more frequently in contact with their close-knit group of people (Fehr, 2000). These positive feelings are important for people to sustain their relationships.

Even when people are moving away, they tend to have close relationships with primary groups such as family (Stafford, 2004). Researchers in social sciences have shown the importance of the quality of close relationships on individuals’ psychological well-being (Mashek & Aron, 2004). Additionally, researchers studying close relationships have acknowledged the importance of parent-child closeness in human existence as they are one of the most enduring relationships.

Romantic relationships or friendships may come and go, but most people spend most of their lifetime in relationships with parents or their adult children (Bedford & Blieszner, 2000). Even if people are not physically together, they may still mentally and emotionally affect people. Golish (2000) reported ten different turning points in parent-child relationships, which signified a point in time where the relationship experienced change that affected closeness. `Physical Distance' was highlighted as one of the main turning points where feelings of closeness in the relationship were found to have changed. This suggests that there is a need to ensure close-knit groups such as parent-adult children that are geographically separated are connected.

2.3 Long distance parent-adult child relationships

We have just discussed how distance can have a significant impact on relationships. The aim of this thesis is to develop an understanding of how to support long-distance parent-adult child relationships through the design and application of communication technologies. To achieve this, we first need to understand what is known about parent-adult child relationships. Good discussions of this area can be found in (Stafford, 2004) and (Lye, 1996). Throughout this thesis `distant relationship' or `long distance relationship' refers to parent-adult child relationships where they live separately from each other.

As mentioned in the previous section, parent-adult child relationships are one of the most important relationships in an individual's life, and they will likely spend the largest part of their lives in this relationship with their parent (Fingerman, Kim, Birditt, & Zarit, 2016; Lye, 1996). As people grow up, they often move geographically away from their families. This could be because of various reasons such as better work opportunities, studies or simply growing up and moving out of their parent's house. This varies in different cultures for example in some Asian, African and Hispanic societies it is more common for adult children to live with their parents than White-Caucasian families (Stafford, 2004).

Some studies show the adverse effect of adult children moving away on parents psychological well-being with ranging levels of depression and loneliness also referred to as 'empty nest syndrome' (Barber, 1989; Raup & Myers, 1989; Wu et al., 2010). Emptying the nest refers to the phase of the adult life cycle that occurs when children are growing up and start leaving home one after the other (Harkins, 1978). Some studies carried out on American sample report contradictory findings suggesting "emptying the nest" could improve life satisfaction. However, it was only under two conditions: when there was frequent contact with non-resident children or when there were other teen children still living at home (White & Edwards, 1990). Authors found that parents with an empty nest and infrequent contact with adult children reported reduced life satisfaction. This provides evidence that adult children leaving home could have a detrimental effect on parent's psychological well-being

and frequent contact with non-resident children is important for parent's life satisfaction.

It has historically been considered that face to face contact is a requirement for creating and maintaining close relational ties and geographic proximity is a necessity for close relationships. Indeed, from the 1900s, academic interest in intergenerational family relations had often been tied to concerns about the weakening of family bonds in the West. Urbanization and industrialization had led to traditional extended family ties degrading, with parents and their adult children isolated and alienated from one another (Mancini & Blieszner, 1989). Over more recent decades, however, researchers rejected this school of thought, turning away from the myth of the isolated nuclear family. The key work of Litwak (1960) presented nuclear family relations in a new light. He argued that family members maintain relationships even when separated by large distances. Since then, a large body of research has verified that parents and their adult children remain linked and close throughout their entire lives, regardless of distance and culture (Bengtson, 2001; Eggebeen & Hogan, 1990; Grundy, 2005; Grundy & Shelton, 2001; Lye, 1996; Parreñas, 2005; Swartz, 2009)

Importantly, despite distance, parent-adult children stay in frequent contact and share satisfying relationships (Fingerman, Cheng, Tighe, Birditt, & Zarit, 2012; Fingerman et al., 2016; Hay, Fingerman, & Lefkowitz, 2007; Lye, 1996) and are still considered more caring and close compared to other relationships (Williams & Nussbaum, 2013). Therefore, it could be said distance is simply something which presents special challenges such as managing availability and requires developing new communication routines and personal understanding.

2.3.1 Theoretical perspectives

To be able to study how technology may support a parent-adult child relationship it is important to understand how this relationship functions as a whole. It is important to acknowledge the factors that may have an effect on communication and relationships between parents and their adult child which are beyond the technology use. In this section, we discuss various theoretical perspectives on parent-adult child relationships in order to set a context of our work.

Intergenerational solidarity theory embodies the traditional theoretical framework for research on parent-child relationships. The family is understood as a social group grounded in harmony and solidarity. Members share customs and values and go about the function of help and care (Komter & Vollebergh, 2002). Bengtson and Schrader (1982) view intergenerational family solidarity as being made up of the relationship of six constituents: function (or instrumental support), affection (or emotional link), consensus (or agreement on attitudes), familism norms (commitment to perform family roles and obligations), association (or contact), and the opportunity structure (such as geographical proximity). These six dimensions of solidarity are

found to be indicators of family ties. For example, families with strong affective ties are, likely to have frequent interactions, close geographical proximity and high amounts of support exchange between generations. However, these six solidarity elements cannot be combined to form a single additive scale or create a unitary construct (Bengtson & Roberts, 1991). Therefore, rather than being a unique measure, the intergenerational solidarity model emphasizes the multidimensionality and complexity of family relationships.

Intergenerational solidarity theory provides a positive association between affection which is also defined as emotional closeness and contact which may include face to face as well as a contact using communication technologies (Lawton, Silverstein, & Bengtson, 1994). Lawton et al. (1994) report reciprocal influence between affection and contact for mother-adult child relationship but not for father-adult child relationship suggesting a motivation for contact with mother is different than with father. They also report approximately 80% adult children feel emotionally close to their parents however the father-child relationship is less close than a mother-child relationship.

Recently, the intergenerational solidarity model has undergone criticism by some scholars highlighting that high solidarity doesn't necessarily correspond to low conflict and vice versa. The classical sociology of Simmel (1904) claims that the simultaneous existence of tension and harmony is unavoidable in small groups such as families. With these arguments in mind, the theory of intergenerational ambivalence was developed to better represent the mixture of positive and negative attributes of parent-child relationships.

Intergenerational ambivalence refers to "contradictions in relationships between parents and adult offspring that cannot be reconciled" (Lüscher & Pillemer, 1998, p. 416). It encompasses two key dimensions; firstly, individual or psychological ambivalence is the ambiguity of feelings felt by an individual. Psychological ambivalence encompasses coexisting feelings of love and hate toward an individual. Secondly, sociological ambivalence was derived by Merton and Barber (1963, p. 94) and deals with the "incompatible normative expectations of attitudes, beliefs, and behaviour" that arise due to social-structural positions or roles.

As well as Intergenerational solidarity theory and Intergenerational ambivalence focusing on more direct aspects of the parent-adult child relationship, it has been shown more indirect aspects can also have an influence. Elder (1998) introduced a concept named "linked lives" which stresses the interdependence of the life courses of family members. For example, adult children developing romantic relationships lead their parents to take on new family roles, such as parents in law. The birth of a child into a family bestows the role of parenthood onto adult children, but also heralds a transition of parents into grandparent roles. The concept of linked lives also suggests that the well-being of one generation is affected by events in the lives of

other generations. For example, parents often feel accountable and worry about the lives of their children (Hay et al., 2007; Lawton et al., 1994; Pillemer, Suitor, Pardo, & Henderson, 2010). The linked lives concept also posits changes in the lives of family members can affect intergenerational solidarity by altering relationships within the family (Connidis & McMullin, 2002). This can occur by a few mechanisms, such as changing needs of a family member or altering parent-child closeness and similarity.

Magai and McFadden (1996) further explored the idea of life events of one generation affecting another. They claim parents not only seem to preserve a strong idea of connection and compatibility with their children, but that their own emotional state seems affected by their sense of the well-being and success of their offspring. Parents do come to terms with their grown children moving away from them; however their idea of how their adult children 'turned out' affects them greatly. This is less relevant for adult children who are commonly less emotionally invested in their parents' lives. Nevertheless, they still experience complex emotions within this relationship. This is explained by intergenerational stake hypothesis which states that parents are more invested in their children and experience better quality parent-child ties than their children.

At different ages, individuals may enter into different life courses. For example, starting university, getting a job, getting married, having children. It is particularly important to recognize the connection between the nature of life course changes of one generation and the frequency of contact with other generations. Studies in this area suggest that the amount of contact and the quality of relationships increases if parents and their children transition to becoming more similar in their statuses and circumstances (Aquilino, 2005; Pillemer, Munsch, Fuller-Rowell, Riffin, & Suitor, 2012). In fact, Ward, Deane, and Spitze (2014) have shown that adult children have an increased frequency contact with their parents when they transition into becoming parents themselves.

Research on intergenerational solidarity have consistently reported gendered differences in affection (emotional closeness) as well as interaction (Lawton et al., 1994). Following this, gender theory has been used in recent research on the parent adult-child relationship to explain patterns of family interactions often controlled by gender. As women undertake the gendered work of kinkeeping, they become more involved in kin networks and may dictate the extent of men's access to kin (Furstenberg & Cherlin, 1991; Lye, 1996). It is possible women could be further involved in adult child-parent relationships because they often give higher importance to close emotional bonds with family members (Silverstein et al 1995) and exhibit more compassionate and altruistic behaviours than their male counterparts (Beutel & Marini, 1995). Furthermore, due to women's greater provision of family services during their early and middle adulthood they may enjoy greater access to support in late adulthood (Rossi, 1990; Spitze & Logan, 1990b).

Unmarried men in contrast are more likely to have weaker access to kin networks (Goldscheider, 1997).

In summary, parent-adult child relationships are influenced by direct and indirect factors such as direct shared values and indirect life events. Additionally, distance has a large influence on this relationship and needs to be accounted for in any research into this area. All of these factors are important to consider when studying how parents and their adult children communicate, which is the topic of focus in the next section.

2.3.2 Communication in parent-adult children relationship

In earlier sections, we briefly discussed the theoretical approach for parent-adult child relationships. It was discussed that although distance has an impact on the frequency of contact, it does not pose an obstacle to intergenerational relationships. As evidence, the nature of communication within parent-adult child relationships is important. This communication became the subject of much study during the 1990s (for a comprehensive review see Lye, 1996). One area that received attention in these studies was the medium used for contact. In the 1990s, telephone calls, letters, and visits were the most used methods of contact (Lye, 1996). Since that time, however, the internet, in particular, has allowed new avenues of communicating to open up, the increased popularity and pervasiveness of mobile phones has also been a large factor. Family members now have more media to choose from when communicating. Below, the use of communication technologies, theories around technology use and their impact on interpersonal relationships is explained.

Schon (2014) found that the number of media utilized to communicate between parents and adult children is important for relational maintenance. The authors found that communication media used by parents and emerging adult children to maintain their relationship does modestly influence communication and relationship satisfaction. Furthermore, their results implied that utilizing additional media can offset a parent's low communication competence and increase relationship satisfaction in parent-adult children relationship. However, their study was focused on emerging adults and does not take the parents' side into account. Therefore, it is not known if these findings apply for adults in other age-groups and parents. This does however indicate that additional media use could be beneficial for this relationship.

As well as the number of media used, Dainton and Aylor (2002) found that the type of communication media was important, with different media meeting needs in relationships. It was found that internet use and telephone were positively associated with satisfaction levels in a relationship. However, they do not properly define the 'internet' and could mean audio-video conferencing, emails or Instant messages

(IMs) therefore it is not possible to clearly understand which exact ICT technologies are related to relational satisfaction.

Media niche theory has been proposed by Dimmick, Kline, and Stafford (2000) to explain why different types of media meet different needs within a relationship. They found that telephone conversations were more effective at providing emotional expression than email. They also found that text messages were superior to telephone and telephones were superior to emails in providing gratification (Dimmick et al., 2000). The scope of this work is limited however as the study did not focus on parent-adult children relationships. Furthermore, the data is focused on generalized opinions on communication use, rather than the attitudes tied to actual use. It is unclear how valid it would be to extend the findings of such data to parent-adult child interactions. Importantly, however, it does indicate that different types of media can satisfy different needs.

One of the key types of media that could fall under media niche theory is mobile phones. Mobile phones allow people to stay in contact with their family members. However, researchers have questioned whether the mobile phone forced family members apart or if it brought them together (Matsuda, 2005a). On the one hand, Martin and de Singly's study (as cited in Haddon, 2004) reported that some teenagers used the mobile phone to escape from interactions with their parents. On the other hand, researchers (e.g., Castells et al., 2007) reported that better parent-adult child relationships were fostered by the mobile phone.

Chen and Katz (2009) findings reported that the mobile phone is “a must” for college students to keep in contact with their family. Other findings suggest that college students use mobile phones to have more frequent contact with their family and to fulfil family roles. College students also utilize mobile phones to share experiences and emotional and physical support with their parents. However, this study focuses on college students and does not take the parents’ side into account. They also report a mobile phone as an ICT without clearly differentiating between phone calls, text messaging, emails and instant messaging using mobile phones.

Other researchers who also look at mobile phone use within parent-adult child relationship argue that the mobile phone may function as a “pacifier for adults” (Townsend, 2000, p. 93) since it supports connections, and in particular emotional connections, with their parents. The mobile phone can help users who are away from home to fill in time gaps and deal with loneliness. In addition, it can be used to ask for advice from loved ones at homes (Geser, 2005). Palen, Salzman, and Youngs (2000) and Ling (2004) found that the mobile phone allowed parents and children to retain connections during periods of spatial distance. The Carphone Warehouse's study showed that the 18– 24-year-olds attested to their mobile phones strengthening their friends and family networks (Warehouse, 2006).

Although mobile phones provide easy connectivity to family members, some research has found a major cost of using them. For example, Kushlev, Proulx, and Dunn (2016) found that constant notifications from mobile phones resulted in higher levels of inattention and hyperactivity. Higher levels of inattention, in turn, predicted lower psychological well-being. Many other researchers have found these interruptions at inappropriate moments can adversely affect psychological well-being and impact the emotional and affective state of the user (Bailey & Konstan, 2006; Czerwinski, Cutrell, & Horvitz, 2000a; End, Worthman, Mathews, & Wetterau, 2009; Horvitz, 2001; Monk, Boehm-Davis, & Trafton, 2002). Also, users might get annoyed when they receive notifications presenting information that is not useful or relevant to them in the current context (Czerwinski, Cutrell, & Horvitz, 2000b).

We have already discussed that distance poses a challenge in maintaining a relationship and has an impact on the frequency of contact between parent-adult child relationships. However, parents and their adult children share a close relationship and still may desire to stay in touch with each other. For example, Tee, Brush, and Inkpen (2009) reported that most of their participants desired more contact with their distant adult child as well as their parents. They found that most of the participants expressed a desire for more communication and sharing with their extended family, however, found it hard due to a busy schedule and lack of technology use by extended family members. Rubin (2015) also reported that the need for contact between parents and adult children is expected to grow. Therefore, we argue that despite the availability of traditional communication technologies, there is still a need for designing novel technologies that will minimize the costs of using communication technologies and allow people to stay in touch within this relationship.

To summarize, we have discussed that communication technologies in parent-adult child relationships are important for relation maintenance and designing of technologies to support this relationship can have a positive impact. Mobile phones are important for the maintenance of the relationship, but they do come at a cost. In this thesis, we do not intend to replace traditional communication methods using mobile phones, however, suggest new ambient designs to supplement the existing communication for a cohesive experience.

2.3.3 Media multiplexity theory

In this thesis, we propose designing technologies to support long-distance parent-adult child relationships which might be used in addition to the media routinely used to maintain their relationship, resulting in increased in the total number of technologies used. The media multiplexity theory (MMT) explains the association between the number of media used and relationship strength (Haythornthwaite, 2005a). MMT posits that more strongly tied pairs make use of more of the available

media to communicate with one another. Simultaneously, the addition of media could be useful for strengthening the interpersonal relationships.

MMT is derived from studies carried out using a social network approach to communication, which focuses on who is communicating with whom in a group, the frequency they communicate, what types of media they use, and the content of what they communicate about. These studies often indicate that people tend to form two types of ties within a social group. People with "weak ties" (e.g. casual friends, acquaintances) will likely communicate infrequently and largely for practical purposes (Haythornthwaite, 2005b). Such people are likely to be dissimilar and members of different social circles which, interestingly, makes interaction advantageous as it brings new information and resources to each person in the weak tie (Haythornthwaite, 2002). "Strong ties," (e.g. family, romantic partners and close friends) however, will frequently communicate for various reasons, such as social support, friendship, practical needs and advice (Haythornthwaite, 2002, 2005b). This is in line with the categorization provided by Huijnen et al. (2004) about primary and secondary social groups we discussed earlier.

Haythornthwaite (2005) in her previous research, (see Haythornthwaite & Wellman, 1998) found that people with strong ties use more media to communicate than those with weak ties. A close friendship, for example, has been positively correlated to a total number of media used which is also referred as communication repertoire size (CRS) (Haythornthwaite & Wellman, 1998; Van Cleemput, 2010). Therefore it follows the word 'multiplexity' in the theory relates to the number of different types of media used by two individuals to maintain a relationship (Haythornthwaite, 2002; Haythornthwaite & Wellman, 1998), Additionally, strong ties will always use some private media that involve just two people while it is possible weak ties may only exclusively use more public media, such as Facebook (Haythornthwaite, 2005b).

Haythornthwaite gives several reasons which cause people in strong tie relationships to use more media. Firstly, she proposes people with strong tie relationships may have a greater desire or need to communicate and thus use a larger spectrum of media to enable this (Haythornthwaite, 2000). Additionally, as strong tie relationships communicate for a larger range of reasons, a larger choice of media could be more helpful than it would be for those with weak ties who interact for fewer reasons that are often more practical (Haythornthwaite, 2000). This is supported by research by Dainton and Aylor (2002) who found, different media were used to accomplish different relationship maintenance tasks; In long-distance romantic relationships for example: face-to-face was employed for task-related communication, the telephone used when being open with a partner and also giving assurances, the internet was used to allow positivity and networking, and letters were written for assurances.

MMT, however, has mainly been used in the study of groups, such as classmates (Haythornthwaite, 2000), social networking contacts (Ledbetter, 2009), or members of an online gaming group (Ledbetter & Kuznekoff, 2012). More recently, researchers have begun to examine MMT in interpersonal contexts, geographically close friends being an example (Miczo, Mariani, & Donahue, 2011). There is a little work investigating MMT in the context of family relationships (see Schon, 2013). However, these studies only focus on young adults (up to 29 years old). Also, they do not take the parents' experiences into consideration.

As families can be defined as a group under MMT, there should be a relationship between communication repertoire size and closeness and relationship satisfaction within this group. Relationship satisfaction and closeness are related to an individual's happiness with a relationship with another person (Collins & Read, 1990; Hendrick & Hendrick, 1989). MMT predicts a positive correlation between a number of media used and relationship satisfaction amongst members of a family, since strong ties have been described as "close" and are exhibited by those who share resources, and have a high social influence on one another (Haythornthwaite, 2002, 2005b). Therefore, interactions between family members who display these characteristics could be predicted to involve using a greater number of media. Additionally, relational closeness and relationship satisfaction have been found to be positively and moderately correlated (McManus & Nussbaum, 2011). We explore the relationship between communication repertoire and closeness, relationship satisfaction and connectedness in parent-adult children relationship in online survey studies discussed in Chapter 4.

Having discussed parent-adult child relationships, and communication within this relationship, we now turn our attention to the concept through which we want to support distant relationships - connectedness.

2.4 Connectedness

As previously mentioned, information communication technologies are often used to maintain relationships (Boneva, Kraut, & Frohlich, 2001; Hall & Baym, 2012; Ishii, 2006). Lin and Tong (2007), for example, found two-thirds of participants' text messages were employed solely for relationship maintenance rather than exchanging information. Pempek, Yermolayeva, and Calvert (2009) also discovered the maintenance of offline relationships was a key use of Facebook. This concept of maintaining a sense of connection using communication technologies is called connected mode or connectedness (Kuwabara et al., 2002; Licoppe, 2004; Rettie, 2003) and describes a feeling of emotional connection that does not require individuals to be physically together (Licoppe & Smoreda, 2005).

Rettie (2003, pp. Connectedness section, para 8) argues that in connected mode, communications “help people to be aware of each other”. In a study Licoppe (2004) found a contrast between connected mode and conversation mode; in conversation mode, the goal is to relay information or talk, whilst in connected mode making contact is the sole purpose. One participant in the study stated how these “connected mode” messages indicated to the recipient that the sender is thinking of them. These messages that induce connectedness could be greetings or reassurances, where the message content is less important than the fact that communication is explicitly initiated (Licoppe, 2004; Rettie, 2003). Two examples presented by Licoppe (2004) from his findings are: “I miss you” and “I’m thinking of you”. Rettie (2003) argues physical messages do not even have to be sent, a technology that enables distant people to listen to music together can also create a sense of connectedness.

Chayko (2008) reported that some people could be comforted by a feeling of constant presence. Indeed Miller-Ott, Kelly, and Duran (2012) found that college students who were in contact with their romantic partner as frequently as they liked described having greater relationship satisfaction. Rettie (2003) discovered that an individual’s need for connectedness was at its highest when romantic partners or close family members were involved. Both Licoppe (2004) and Rettie (2003) reported mobile phone calls and text messaging were two popular methods to achieve connectedness. Katz and Aakhus (2002) found mobile phone use can actually encourage people to desire constant contact. As the use of social networking sites on mobile phones becomes increasingly popular, that medium, too, may increasingly be used to achieve connectedness. In support of this, Kuwabara et al. (2002) argued that connectedness oriented technologies might be better in supporting close interpersonal relationships than content oriented technologies.

As well as being studied from a technological standpoint, the need for connectedness is recognized in psychology: Adler's (1998) concept of social interest refers to an individual's attitude and relationship to society, or 'social connectedness'; this factors in both success in life and mental health. In social psychology (Smith and Mackie, 2000) the pursuit of connectedness is one of the three basic motivating principles which underlie social behaviour; this fundamental need for belonging and connectedness promotes social relationships.

It is important to highlight connectedness in this thesis relates to interpersonal connectedness, which is directed at an individual, as opposed to social connectedness which refers to the connectedness someone has to their social world in total (Lee & Robbins, 1995). In this thesis, we are interested in supporting a sense of emotional connectedness, a feeling of ‘being in touch’ with someone which is evoked by the use of communication technologies. Therefore, we use the definition of connectedness in the context of communication technologies which as Romero et al. (2007, p. 303) defines is “a positive emotional appraisal which is characterized by a feeling of staying in touch within ongoing social relationships.”

There has been some previous research on connectedness in parent-adult child relationships especially surrounding mother-adult daughter relationships (Rastogi, 2002; Rastogi & Wampler, 1999) However; these researchers conceptualise connectedness as an ability to share feelings and opinions as well as making sacrifices. Although this refers to interpersonal connectedness, their definition comprises of emotional closeness, attachment, support and intimacy in a mother-daughter relationship and does not take communication into account. We argue that although interrelated, connectedness, closeness, attachment, support and intimacy are not the same concepts (Hudson & Fraley, 2017; Mashek & Aron, 2004). Connectedness refers to the feeling of 'being in touch' or being connected which is facilitated by communication technologies and could be felt for over a period of few days or weeks. Whereas emotional closeness is conceptualised as high interdependence and self-disclosure between two peoples (Aron, Aron, & Smollan, 1992; Kelley et al., 1983; Mashek & Aron, 2004)

At the beginning of this chapter, we argued that most adult children and parents have close relationships. However, this does not necessarily mean they are satisfied with their level of connectedness when living away from each other. Although mobile phones and social networking websites allow people to achieve connectedness, it has been found that younger adults use more communication technologies than older adults (Horrigan, 2007; Smith, 2014; Zickuhr, 2011). Similarly, there have been multiple studies that have found a negative association between technology use and age (Horrigan, 2007; Selwyn, Gorard, Furlong, & Madden, 2003; Zickuhr, 2011). This indicates that in the context of parent-adult children relationships, parents may be less connected than their adult children. For example, it has been found parents are less likely to use a mobile phone than their adult children (Ishii, 2006). Supporting this, Zickuhr (2011) also found that whilst 95% of those aged 18-34 owned a mobile phone, this percentage dropped to 85% for people in their late 40s and 50s. The same pattern is also true for text messaging (Lin & Tong, 2007; Reid & Reid, 2010). 18-29-year-olds were, 97% likely to send text messages, whilst only 72% of people in their 50s and early 60s do (Pew, 2012). Moreover, although many older adults' text, they may be less capable of it or use it less regularly (Yoon, 2003). These trends could lead to adult children who desire high levels of connectedness expectations not being met as their parents may not utilize mobile phones or text messaging often or at all. This could then cause dissatisfaction within the relationship (Schon, 2013). This further gives a rationale for the need of designing novel, easy to use connectedness-oriented technologies to support distant parent-adult children relationships.

To conclude, we have discussed the importance of connectedness and the rationale for using connectedness as a phenomenological concept to evaluate communication technologies. We have explored where the concept of connectedness is used in previous research of parent-adult child relationships, and it is argued that it has

sometimes been inaccurately combined with the concept of closeness. We also highlight connectedness is of particular interest in the study of the parent-adult child relationship as there is a disparity in ICT use across this age asymmetric relationship. This can result in connectedness expectations not being met when the individuals in the relationship are separated by distance.

Another concept that is closely related to connectedness and is also of interest in this thesis is a social presence. In next section, we discuss the importance of social presence as a concept and why it is considered in this thesis.

2.5 Social presence

Broadly, there are two categories of how physically distant people could feel that they are in the presence of the other. First is feeling the physical presence which refers to the sense of bodily being present despite being in remote physical space (Turner & Turner, 2004, 2006; Turner, Turner, & Carroll, 2005). Second is social presence which refers to the sense of togetherness of social interaction with a distant partner using communication technologies (Gooch & Watts, 2014; Howard, Kjeldskov, Skov, Garnæs, & Grünberger, 2006). The concept of social presence is related to the concept of connectedness, but it is not equivalent. Social presence is the cognitive perception of 'being together' with the other person when communicating via ICT and is short-lived whereas connectedness refers to the emotional feeling of 'being in touch' or being connected over a period of time.

In their review of the literature, Lombard and Ditton (1997) proposed six conceptualisations of presence: realism, immersion, transportation, social richness, the medium within social actor and social actor within the medium. They can be divided into two groups, physical and social presence. In the context of computer-mediated communications (CMC), physical presence refers to the concept of a 'being there' feeling while using telecommunication systems whereas social presence refers to the feeling of 'being together' (De Greef & IJsselsteijn, 2000).

There are multiple definitions of social presence in the context of different technologies. Short, Williams and Christy (1975) first defined social presence in the context if communication technologies as the "degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships" (p. 65). Heeter (1992) refers to the social presence in the context of virtual reality as the feeling of "being with others" in a virtual or networked environment. Biocca and Harms (2002, p. 3) refer to the social presence in the context of collaborative work or education system as a "level of co-presence of another human, being or intelligence". All these definitions in a way refer to the feeling of 'being together' in interaction using technology.

Social presence is linked with two concepts, “intimacy” and “immediacy”. Short et al. suggested that the degree of social presence of a particular medium adds to the feeling of felt intimacy and it depends on physical distance, the direction of looking and eye contact. This suggests that a video communication channel has a higher degree of a social presence than audio-only channel as a video communication channel such as Skype has the ability to convey non-verbal cues via facial expression. Immediacy refers to the psychological distance between the communication channel and its user. Gunawardena and Zittle (1997) suggested that immediacy improves social presence.

Short et al. (1975) referred to this concept as a property of medium used for communication and suggested that the degree of felt social presence depends on the ability of that medium to convey verbal and non-verbal cues. Therefore face to face communication was suggested to have the maximum level of social presence and written communication to have the least. However, some other researchers have argued that “Social Presence cannot really be conceptualized as a fixed property of the medium. Rather it is best conceptualized as a property of individual perceptions of mediated others, that likely fluctuates during interactions, tasks, and individual differences” (Biocca & Harms, 2002, p. 30). Social presence, according to Biocca et al., is thought to change over the time during the interaction. It varies from low-level interaction to high level, for example initially having a sense of another person being co-present to increased awareness of the other person’s intentions.

There is a lack of clarity in the literature around the concept of social presence. Some researchers use the concept of social presence interchangeably with emotional connectedness (Gooch & Watts, 2014). Other researchers, as mentioned before, argue that it is a property of a medium whereas others argue there are other factors such as media characteristics and also of people (i.e. user characteristics) (IJsselsteijn & Riva, 2003). In this thesis, we take the view that social presence is a property of communication, which is affected by the communication media used as well as other factors such interaction and individual user differences. This concept has received much focus and is used by many past researchers in the analysis and development of communication technologies (Davis, Hu, Feijs, & Owusu, 2015; Gooch & Watts, 2010, 2014; Huijnen et al., 2004; IJsselsteijn, van Baren, & van Lanen, 2003). Therefore, we chose to use the concept of social presence while evaluating the first of our technology design, the *SmartLamp* in Chapter 3.

2.6 Closeness in long distance relationships

Social presence and connectedness are concepts related to communication and to understand how they may affect people’s relationship, we need to explore if these have any connection with other relational concepts. If social presence and connectedness only have an effect on communication, it is difficult to propose that they are worth supporting. However, if they are associated with a longer-term

relational concept, then the design of communication technologies that evoke these feelings can have a much more significant impact. Closeness has been proposed as such a concept. It is reported as an essential element in the development of personal relationships (Golish, 2000). Some even argue that is the most important relational concept in the context of interpersonal relationships (Aron et al., 1992; Mashek & Aron, 2004). The association between social presence and closeness has been investigated in Chapter 3. The association between connectedness and closeness has been investigated in Chapter 4. To understand if there is a connection between social presence and connectedness with closeness, it is important to understand what the meaning of closeness in the context of the relationship of interest is.

There are a few key elements that underpin the concept of closeness. Firstly, in the literature, 'close' is related to two concepts; relationship *type* (i.e. close relationships) and relationship *quality* (i.e. closeness in a relationship*)* (Ben-Ari & Lavee, 2007). Secondly, communication acts influence feelings of closeness in a relationship (Altman & Taylor, 1973). Finally, the feeling of closeness is a longer term relational concept as compared to a social presence which is a short-lived feeling as well as connectedness which is also a temporary feeling felt over a few days or weeks.

Ben-Ari and Lavee (2007, p. 627) conceptualize closeness with three main distinctions: "a relatively stable relationship *trait* versus a fluctuating situational *state*; emotional versus physical closeness; and the constructed meanings of closeness versus its expressions". The first two distinctions are relatively clear; the third one needs further elaboration. The constructed meanings of closeness relate to how psychological closeness makes someone feel. The expression of closeness relates to how that feeling is expressed physically. It is important to note that in this thesis, we focus on emotional closeness rather than physical closeness as the relationship we are studying is not physical in nature.

In the same manner, as presence, closeness has a familiar colloquial meaning. In the literature, it has been considered as a multidimensional construct which consists of frequency, diversity and the strength of interaction between two people. The conceptualisation of closeness in a widely used relationship closeness inventory (RCI) refers to the high interdependence between two people's activities (Berscheid, Snyder, & Omoto, 1989). It is based on the definition of closeness given by Kelley et al. (1983, p. 13) which says "A high degree of interdependence between two people is revealed in four properties of their interconnected activities: (1) the individuals time frequent impact on each other; (2) the degree of impact per each occurrence is strong; (3) the impact involves diverse kinds of activities for each person; and (4) all of these properties characterize the interconnected activity series for a relatively long duration of time." However, their definition is problematic as one of the main factors characterising closeness according to this definition is doing activities together and the impact of those activities on the individual. Following this, the RCI scale includes many items to rate activities done together such as watching TV, doing

laundry, going for a walk, restaurant or preparing a meal. However, people that live away may not engage in these activities yet still maintain emotional closeness with each other. Hence this definition and this scale is not suitable in the context of a geographically distant relationship.

Aron et al. (1992) reviews several conceptualisation and definition of closeness and defines closeness as 'inclusion of the other in the self'. It is based on the idea proposed by Levinger and Snoek (1972) represented as a Venn diagram as shown in Figure 1. This concept does not only rely on activities done together and focuses on people's perception of inclusiveness of the self and the other. We believe this view gives a more accurate conceptualisation of closeness, therefore, this definition is used throughout this thesis.

Based on this conceptualisation Aron et al. propose inclusion of the other in the self (IOS) scale which is validated and has high reliability and is popularly used to measure closeness. Notable uses of this scale include, (Baumeister & Leary, 1995; Brewer & Gardner, 1996) and in the area of HCI see (Gooch & Watts, 2011b). As this scale has been used successfully in the past by a wide range of researchers and it is a validated scale. Therefore, we use this scale to measure closeness in this thesis.

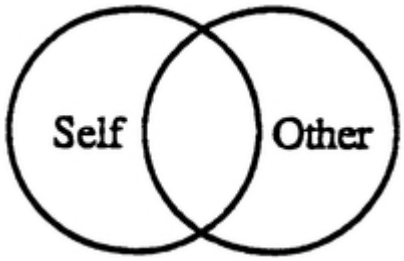


Figure 1. Pictorial representation of including other in the self in a close relationship (Levinger & Snoek, 1972).

It has been found that the people who report being high in closeness in a relationship report a greater amount of satisfaction than those in a low closeness relationship. Therefore it is an important concept to be studied (Aron et al., 1992). Additionally, people that report high closeness also report more frequent contact with each other (Berscheid, Snyder, & Omoto, 2004; Gooch & Watts, 2014). Altman and Taylor (1973) suggest that communication acts in various stages of self-disclosure affect closeness in a relationship. There have been multiple studies showing a bi-directional association between closeness and contact suggesting people who have more contact are likely to get closer, and people who are close are likely to have more contact (Altman & Taylor, 1973; Canary, Stafford, Hause, & Wallace, 1993; Valkenburg & Peter, 2007). In terms of parent-adult child relationship, most researchers report a high frequency of contact and emotional closeness between dyads (Lye, 1996). The frequency of contact seems to be a common element in the concept of closeness and

connectedness. Therefore we hypothesise that there likely to be an association between these two. We explore this association in Chapter 4 and 5.

Closeness is a longer term relational concept and in the context of parent-adult child relationships, it can change over time depending on different events and stages in a person's life (Golish, 2000). Literature of family closeness suggests, the closeness between parent-adult children relationship is especially complex and therefore needs more investigation. In the field of communication and technology, there is not enough research concerning the nature of closeness in parent-adult child relationship. Especially there are no studies that investigate how the temporary feelings of social presence and connectedness that are elicited by the use of communication technologies may affect closeness in this particular relationship.

To conclude, we have discussed what we mean by closeness and the importance of studying closeness in parent-adult child relationship. In this thesis, the concept of closeness is mainly used to assess whether the devices we design using off-the-shelf IoT products, provide a level of relational support over a longer time scale than connectedness or social presence. In Chapter 3 we investigate the association between closeness and social presence. In Chapter 4 and 5 we investigate whether there is any association between feelings of closeness and feelings of connectedness.

2.7 Devices to support long distant relationships

The importance of supporting long distant relationships has been recognized in the HCI community, and there has been a growing interest in designing and researching novel technologies to support close relationships. We reviewed almost 200 artefacts (design concepts, objects, and technologies) from the literature between 1996 till 2018 (see Appendix A). Previous studies have shown that researchers and designers use six design strategies to mediate interpersonal relationships to make them feel connected or in-touch with each other when they are not physically together (see Figure 2). They are awareness, expressivity, physicalness, gift giving, joint action and memories (Hassenzahl et al., 2012).

'Awareness' technologies create a feeling of cognitive awareness of a distant person by sharing various types of ambient information which could be about an activity or mood or their presence at a place (Pensas et al., 2012; Romero et al., 2007). 'Expressive' technologies allow users to send affective messages to express their feelings or mood or to send 'thinking of you', 'love you' or even an abstract message that a user can interpret themselves (Kaye, 2006). Artefacts that employ 'Physicalness' strategy allow physical intimacy for example hug, kiss, handholding and other physical behaviours over the distance (Angelini, Caon, Lalanne, Khaled, & Mugellini, 2014; Gooch & Watts, 2010; Samani et al., 2012). Artefacts that employ 'Gift giving' strategy allow the digital gift-giving behaviour to express care and value of the other person (Feltham, Vetere, & Wensveen, 2007; Thieme et al., 2011).

An artefact that employs 'Joint action' strategy allows people to do things together at a distance which would usually require people to be physically together, for example, cooking together, watching TV together (Chai, Soro, Roe, & Brereton, 2017; Huijnen et al., 2004). Finally, an artefact that allows 'Memories' strategy allows people to keep a record or to elicit part memories or special moments in a relationship.

Although these six design strategies were proposed as the main design strategies used by researchers in earlier studies, the artefacts cannot be simply categorised as of one strategy or the other. Some of them may employ a combination of various strategy, for example, *ComSlipper* was a pair of slippers that a user could wear to create awareness as well as express availability and 'thinking of you' therefore employ awareness as well as expressivity strategies (Chen et al., 2006). They could also be categorised as physicalness as both partners were meant to wear the slippers which are similar to *touch* over the distance. This indicate that artefacts cannot always be rigidly categorised into one or the other strategy.

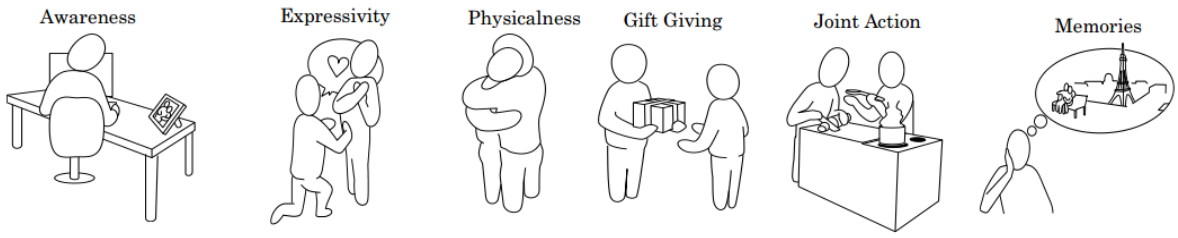


Figure 2. Six strategies used to construct artefacts to support distant relationships (Hassenzahl et al., 2012)

Out of all the six strategies explained above, we believe that 'physicalness' might not be suitable to support parent-adult child relationship. The reason is physicalness artefacts are designed to convey gestures such as a kiss, wink or other types of physical intimacy. Although parents and their adult children may miss hugs or supportive touch such as a 'pat on the back', they do not engage in other intimate behaviours. Therefore, these artefacts might not be appropriate for them hence they are out of the scope of this thesis. Although we believe joint action, gift giving and memories might be good strategies to support this relationship; we narrow the scope our work by focusing on awareness and expressivity strategies and propose that the other strategies could be explored in future work in Chapter 6.

Having briefly explained all six strategies, we now focus on discussing awareness and expressivity as they are of main interest to this thesis. In this thesis, we explore how well awareness created via connected lamp (see Chapter 3) and expressive messages sent via connected jewellery (see Chapter 5) could support parent-adult child relationships. In this section, we discuss some of the artefacts that we found most relevant to our work.

2.7.1 Awareness systems

Awareness has been the subject of research in CSCW and HCI since the early 1990s (Rittenbruch & McEwan, 2009). The focus was initially on the workplace, with the awareness of colleagues' presence, availability and activities being considered. As well as the HCI field enlarging its scope to include studying awareness in the home as well as the workplace, and tasks as well as experiences (Rogers, 2012), the focus of awareness studies also widened. Awareness is now being considered not only for its influence on effectiveness but also its affective benefits including feelings of connectedness. We discuss some of the relevant literature to support connectedness in the following section.

Awareness is defined as a "state of knowing about the environment in which you exist; about your surroundings, and the presence and activities of others" (Wisneski et al., 1998, p. 24). Awareness devices are intended to create presence of the remote person by providing some peripheral information or surrounding information about the other person. As mentioned before, some researchers believe that awareness created by the other persons' presence is sufficient for creating a sense of connectedness (Kuwabara et al., 2002; Rettie, 2003).

A piece of notable work in the area of peripheral awareness was by Ishii and Ullmer (1997) who designed tangible bits that provide peripheral awareness and implicit experience in a way that they do not demand the primary attention of the person using them and are unobtrusive in nature. The focus of their work was on the design and architecture of building these technologies. Although inspirational, there is no detailed evaluation of these design prototypes with users therefore not much is known about how they can support close interpersonal relationships. However, this was one of the earlier works which became an inspiration for other researchers to think about peripheral awareness and presence in the context of interpersonal relationships. Their work indicated that the artefacts made for conveying presence information might be significant in close relationships as they do not enable users to directly communicate with one another but only transfer the feeling of the presence of the other.

Dey and de Guzman (2006) designed picture frames and mirrors to provide awareness and support connectedness between friends and family. They carried out a five-week in-the-wild study of the two tangible prototypes which both displayed the 'status' (online, offline, idle, and message received) of their 'loved one' in the frame of the device. They argued technology designs using everyday objects could provide significantly better connectedness and awareness to the loved ones compared to online awareness provided via a graphical display (Dey & de Guzman, 2006). They argued that it was because their artefacts were designed for small groups of people, contrary to traditional communication media like an instant messenger that is made for large groups of people such as friends, work colleagues and relatives and do not necessarily fulfil the requirements that are significant for close relationships. Some

design principles have been suggested for awareness devices by Dey and de Guzman (2006) such as these devices should be small, devices that are physical are more meaningful than graphical representation, they should present information peripherally, and they should provide an obvious connection between the loved ones.

This work by Dey and de Guzman (2006) was not focused on parent-adult child relationships; therefore we do not know how these kinds of objects could support closeness and connectedness between this specific user groups. Also, the presence displays provided awareness of being online on computer and not about the physical activity of a user. They also actively instructed participants to look at the display and report the status of distant loved ones in questionnaires throughout the day which could have contributed to increased levels of awareness reported by participants. Although they carry out thoroughly designed evaluations, they do not use validated scales to measure awareness and connectedness. Therefore, we do not know the reliability of their results. We build on their work by employing their principals to our proposed designs (see Chapter 3 and 5). We also employ a similar longitudinal study method to evaluate two of our designs.

In a four-week field study Bales, Li, and Griswold (2011) further studied the impact of implicitly initiated communication by using a mobile application to send location information to a romantic partner's mobile phone app. It was found that being notified of a partner's presence in a known location did prompt feelings of connectedness for 11 out of 14 participants. It was also found connectedness was evoked by the sending of one's own location. One participant stated: "It was nice to go to local places and have him know where I was without having to tell him" (Bales, Li, & Griswold, 2011, p. 70). Vibrations were used for notifications of location awareness; however, it is unclear what role the tactile aspect had in increasing the feeling of connectedness. Also, this study does not define or quantitatively measure connectedness. The authors present their qualitative findings referring to connectedness as a feeling of happiness and visceral feelings mentioned by participants. Additionally, the study focuses on the interaction between romantic couples. Therefore, it is not known how such kinds of the system could support parent-adult children relationship.

A number of studies have reported using passive communication to raise connectedness by linking "unremarkable" routine activities (Tolmie et al., 2002). A few prototypes have linked artefacts used every day, including beds (Goodman & Misilim, 2003), chairs (Tollmar, Junestrand, & Torgny, 2000), slippers (Chen, Forlizzi, & Jennings, 2006), cups (Chung, Lee, & Selker, 2006), and bins (Tsujita, Tsukada, & Siio, 2008). These studies focus on supporting romantic relationship. Therefore, it is not known how well such types of artefacts could support parent-adult child relationships. Also, as mentioned before, these kinds of interactions could

be considered intimate and may not be appropriate for parent-adult child relationships.

The Digital Family Portraits project was developed to support families by providing awareness information. A non-invasive sensor network is used to send key information using an augmented picture frame to provide peace of mind to an adult child that may want to know about their elderly parents living in a separate house. In this manner, the family is supported without causing an undue burden on either member of the family. The authors argue “geographic distance between extended family members exacerbates the problem by denying the casual daily contact that naturally occurs when families are co-located" (Mynatt, Rowan, Craighill, & Jacobs, 2001, p. 333). The initial evaluation lacked the necessary sensing network and instead relied on interviews between the researcher and participants. This limits what conclusions can be drawn from the study but Rowan and Mynatt (2005) have since reported a single participant, long-term case study using the same system. Some of the assumptions made, as well as the sensor network (which could only deal with one elderly participant at a time) again limit what conclusions can be drawn, but the fact that participants carried on using the system when the study had ended indicated its success. The study also demonstrates value exists in passively exchanging information between separated family members which requires little effort.

An important condition for using any communication technology is self-disclosure (Derlaga & Berg, 1987). Without, self-disclosure would be virtually impossible to have any communication between people. Studies have shown that self-disclosure is important aspect of feeling closeness in a relationship and can have positive effect on relationship. Conversely, when an unwanted information is revealed, it can have detrimental effect on a relationship (Derlaga & Berg, 1987; Joinson, 2001). Therefore it is an important facet to be considered while designing awareness artefacts that are intended to provide presence of distant loved ones.

Some concerns have been associated with awareness devices which are privacy, the feeling of controllability and intrusiveness. These need to be addressed while designing a new technology otherwise interactions through these new technologies could be found intrusive. For example, Lottridge, Masson, and Mackay (2009) found that only couples living together recognized the background noise of the partner's environment and the couples living apart found the background sounds of the other person intrusive and strange. Similarly, Neustaedter, Elliot, and Greenberg (2006) found that people want to be aware of their distant loved ones and also feel a sense of duty to be available for the loved ones. The level of information about the activity that the individual is ready to share depends on the how close they feel to the other person (Neustaedter et al., 2006).

Gaver (2003) suggests ambiguity as a solution to address the issues of privacy and intrusiveness which are deemed as a cost of awareness technology. Information

provided in an ambiguous way causes the user to make meaning from it and, for awareness devices, respects privacy and autonomy concerns of the users (Lottridge et al., 2009). Thus, the great advantage of ambiguity is it could reduce the feeling of intrusiveness or being monitored, which naturally arises in many methods for creating awareness.

In conclusion, we have discussed the potential of awareness technologies to mediate interaction that is indicative and not explicit, that passively exchange information to provide peripheral awareness which requires little effort could be of value to distant families as it can recreate naturally occurring incidences when families are co-located. We also discussed that artefacts that are already available in users surrounding and that they provide an obvious connection between people could be of value. Additionally, it has been found that the location sharing supports awareness for romantic couples. Therefore, we argue that there is a possibility such artefacts could support awareness of parent-adult child relationship. There are very few studies on parent-adult child relationship, and little research has been done to find whether these awareness systems create a social presence. We explore the effectiveness of awareness system to support parent-adult child relationship in Chapter 3. We explore if and how the awareness provided by artefacts placed in a user's surrounding could support social presence and closeness in this relationship.

2.7.2 Expressive systems

The communication of emotions and affection, or expressivity, is key to close relationships (Clark, Fitnessand, & Brissette, 2001). This design strategy supports explicit expression and reflection of emotions or feelings in an encoded or enriched way. It incorporates spontaneous, stimulating and playful communicative acts, which sometimes take place in either a synchronous or asynchronous way. The expressivity comprises a variety of different strategies, which can be subdivided into *on-off* and *symbols* (Hassenzahl et al., 2012). The *on-off* strategy refers to exchanging simple on-off signals whereas the *symbols* strategy refers to exchanges of a variety of signals with different meanings.

An example of the first *on-off* strategy is Virtual Intimate Object (VIO) developed by Kaye, Levitt, Nevins, Golden and Schmidt (2005). The authors argued that the telephone, instant messaging or emails are not effective ways to show intimacy in distant relationships. To support intimacy in romantic couples, they developed software that allowed couples an easy way to convey feelings, for example by clicking on a small circle on their computer screen called a VIO to show that they are thinking about them. A user clicked the object on their screen, which changed the colour of the object to red on their partner's screen. This red colour slowly faded over the next twelve hours. Their findings suggested that one-bit information can contribute a surprising amount to a feeling of connectedness. In this case, the sending of a one-bit message was explicitly initiated, and it appears a large part of the

perceived value of the tool was the 'thinking of you' implied by the message. As one participant is quoted as saying: "I knew he was still thinking of me when it would go to red." The authors carried out a short pilot study with romantic couples with a focus on intimacy between romantic relationships. We do not know how suitable such designs might be in the context of parents and adult children. In the evaluation of this study, the data was collected using log books that asked various questions on Likert scales, the details of which are not specified. The data collected by the logbooks is not presented, and the authors argue that the results from Likert scale questions were not useful in understanding how the technology was used. Despite the drawbacks of their evaluation, their findings do indicate the potential of simply sharing minimal one-bit information could engender feelings of connectedness. Their findings also suggest that relying solely on Likert scale data might not be effective in evaluating such artefacts.

An example of the *symbol* design strategy is ComTouch (Chang, O'Modhrain, Jacob, Gunther, & Ishii, 2002). This is a mobile phone that has pressure sensors on the side and back, which enables the user to squeeze the phone. The degree to which the phone is squeezed is transferred as a proportional vibrational intensity to the other phone. This enables a simple, codified exchange of affection. ComTouch by Chang et al. (2002) is designed to be used with voice; combining the multiple communication types. Though a well-constructed evaluation exists, it focusses upon the functional design rather than ComTouch's capacity to support relationships. Therefore, its effectivity to support close relationship is unknown.

The main benefit of simple *on-off* messages and *symbols* is the ability of each user to interpret the signal how they see fit and give it meaning. Additionally, the context of the message could change its interpreted meaning, for the same person. For example, it could be interpreted that clicking the Virtual Intimate Object (Kaye, 2006) means "Good Morning," whilst a spontaneous click could be interpreted as "I love you" or "I think of you". Furthermore, the simplicity of the signal can mask the emotional content of the communication, which can help mitigate the privacy issue. An example could be making an emotional phone call in a public setting could make a user feel uncomfortable. Also, people may feel uneasy about sharing emotions or calling each other pet-names. As a solution, artefacts based on on-off or symbols can be easily used in public or other specific situations (e.g., a meeting), because only the two people involved know the actual meaning.

A number of objects employing the 'expressivity strategy' have been proposed, including a paired digital finger rings, which could send a gesture using coloured lights embedded in the rings (Miner, Chan, & Campbell, 2001). However, these are mostly conceptual design ideas presented in an abstract paper focusing on how digital jewellery could be designed and what might be their applications. Authors mention about designing early prototypes however there is no mention of any user studies. Additionally, prototypes have been produced which pair photo frames

(Chang, Resner, Koerner, Wang, & Ishii, 2001; Tollmar & Persson, 2002). The designers of these objects mention jewellery and personal photographs have a history of symbolizing connections between people. Most of these are focused on romantic partners; also, little evaluation has been carried out on the likely affective benefits of these prototypes. It is, however, possible to predict that the appropriation of messaging technology for phatic communication as discussed by Licoppe and Smoreda (2005), and Taylor and Harper (2003), is a realistic way of attaining a comparable sense of connectedness.

Phatic communication

A common term associated with technologies that allow expressivity is phatic communication which is colloquially known as small talk. Phatic communication is distinct from the use of communication media as a means to exchange content. Not all communication takes place to exchange content; phatic communication is used to create a link between conversational partners (Senft, 2009; Zegarac, 1998). An example of phatic communication is 'liking' on Facebook something an online friend posted. The networking command `ping' can be used as a technical analogy to phatic communication (Makice, 2009). It is low in informational value, but it maintains or strengthens the existing relationship. Conversely, not participating in phatic communication may weaken the relationship (Vetere, Smith, & Gibbs, 2009). Using cultural probes, Kjeldskov et al. (2004) identified that a large part of intimate communication is undertaken on an emotional rather than factual level, which supports the phatic communication model. It is important to highlight that whilst all intimate communication is not emotional it perhaps deserves greater attention given the focus of this thesis is creating a sense of connectedness through communication mediated by technology.

Licoppe and Smoreda (2005) propose, that although communication technologies traditionally were used to connect people living away from each other, it is being replaced by new patterns of 'connected presence'. This is now being augmented by multiple technologies, messaging in particular, which are frequently used for phatic communication to feel connectedness. "[R]elationships thus become seamless webs of quasi-continuous exchanges […], and subtle experiences of togetherness may develop" (Licoppe & Smoreda, 2005, p. 5).

A common theme for the designs discussed thus far and additionally for phatic messaging, is whilst message content is indicative; the act of sending the message is explicit. An effect of explicitly initiated communication is an obligation to reciprocate is generated (Kaye, 2006; Taylor & Harper, 2003). This can be seen as a cost against the affective benefits the communication brings (Yarosh et al., 2014). Interestingly, however, the effort involved in explicitly sending a message, can also be viewed as a benefit (IJsselsteijn, van Baren, Markopoulos, Romero, & De Ruyter, 2009). Indeed, Kwon, Koleva, Schnädelbach, and Benford (2017) reports people view voice and text messages as well as digital photos as 'gifts'.

There is a fair amount of research carried out that proposes technologies to connect romantic partners over distance (Chung, Lee, & Selker, 2006; Gooch & Watts, 2012b; Goodman & Misilim, 2003; Hansson & Skog, 2001; Kaye, 2006; Mueller et al., 2005; Thieme et al., 2011). Some also consider grandparents or grandchildren (Davis, Vetere, Francis, Gibbs, & Howard, 2008; Ishii & Ullmer, 1997) and some consider families in general however not a lot of research has been conducted that focuses on communication technologies for an adult child-parent relationship. Research that considers family relationships (Harboe et al., 2008; Truong et al., 2004) does not take into account the fact that different relationships have different needs, for example, communication needs for romantic partners are different than those of an adult child and their parent.

The studies discussed in this section point towards the expressivity strategy as being promising, especially pointing towards the thought of a person behind sending the message rather than the content (Baharin, Nor, & Mühlberger, 2008). Similarly, as discussed earlier, Kaye (2006) found partners filled the simple, "empty" action of a button presses with meaningful and personal content. There are however still further considerations to take into account when researching devices for expressivity. Generally, the ability to express and identify emotions accurately varies between individuals. Additionally, systematic gender differences may exist. For example, instrumental actions (such as cooking dinner) are considered more important than affective positive actions (such as saying "I love you") for men. For women, the opposite seems to be true (Brehm 1992). This research suggests that 'expressivity' strategy could be beneficial to support connectedness especially when people are busy or may not always have things to say. We explore the effectiveness of expressive systems and how this strategy could support parent-adult child relationship in Chapter 5.

2.7.3 Methodological issues with artefacts designed for close relationships

As argued at the beginning of the literature review, to design technologies for close relationships, we first need to have an understanding of the people and dynamics between different relationships. In our review of HCI and CSCW literature around technologies to support close relationships, we found only a few researchers that employed psychology theories, models of close relationships while designing artefacts. Even though these literature are overlapping, very few HCI researchers make use of the knowledge available from other social science fields to inform their design. Amongst these, commonly mentioned topics have been intimacy (Chung et al., 2006; Vetere et al., 2005), communication (Lindley, Harper, & Sellen, 2009; Tsujita et al., 2009), love (Pujol & Umemuro, 2009; Saslis-Lagoudakis, Cheverst, Dix, Fitton, & Rouncefield, 2006), closeness (Gooch & Watts, 2011b; Kirk, Sellen, & Cao, 2010) and emotion (Tollmar & Persson, 2002).

There is a wealth of knowledge available from the social sciences about facets of different relationships and communication between close interpersonal relationships. However, most research on designing for close relationships in HCI does not exploit what is known about the relationships from psychology literature and limit their scope to only HCI or CSCW related publications. Hassenzahl et al. (2012) argue that one of the reasons for this could be because of bottom-up approaches in the design of technologies using ethnography and phenomenological-inspired approaches where researchers/designers immerse themselves as a user and make design solutions based on their own experiences of the observed problems. Although it is an important practice and helps designers to build up empathy, which is necessary for sensible design, it underutilizes already existing knowledge about relationships from other fields such as psychology. It is important to note that some of the research we reviewed do not carry out any ethnographic studies nor do they use knowledge from psychology to inform their designs and are based on assumptions or self-experience of problems. We draw on the knowledge from psychology as well as HCI to inform our two designs. We also conduct two exploratory online survey studies (See Chapter 4) to understand the technology use of in parent-adult child relationships as well as to explore the hypothesis that parents and adult children may desire more connectedness than they actually have and that the connectedness and closeness could have a positive association.

Another problematic practice we identified in this review was most researchers did not employ empirical methods in their analysis. In line with this, Hassenzahl et al. (2012) found out of 143 artefacts published in 92 papers only 46% explicitly mentioned a research method. Out of these, most carry out only preliminary empirical explorations of resulting experiences. The most typical methods used were- interviews (King & Forlizzi, 2007), ethnographic studies (Tollmar, Junestrand, & Torgny, 2000), focus groups (Lindley et al., 2009), cultural probes (Kjeldskov et al., 2005) and contextual inquiries (Dey & de Guzman, 2006). Most of the studies used informal interviews, and there were a very few studies that were comprehensive longitudinal studies, e.g., see (Dey & de Guzman, 2006).

This review of the literature points to the potential for creating meaningful emotional communication and presence using technology. However, a significant proportion of papers did not conduct formal user evaluations and lacked longitudinal studies with users to measure the effectiveness of proposed objects (Yarosh et al., 2014). Hassenzahl et al. (2012) found 61% of the studies carried out some evaluation. Out of these only, 25% were longitudinal field studies, and 36% were preliminary (laboratory) studies. Only a few studies are carried out “in the wild” to gain an understanding of how users might actually use the artefacts in a realistic setting. Most field studies were conducted over one to two weeks, and there were very few over four weeks (Yarosh et al., 2014). Most of these field studies were diary studies that asked participants to keep a daily or weekly log of use of the artefact. Most studies included open-ended or semi-structured interviews at the end. On average the

field study employed four couples (eight participants) (Hassenzahl et al., 2012). Therefore, we argue that more research is needed to evaluate the effectiveness of using these objects in distant relationships. Therefore, in this thesis, we carried out longitudinal evaluations of proposed artefacts in the wild to understand how well they support distant parent-adult child relationships.

Only a small number of exploratory field studies mentioned or employed standardized tests to capture the mediation of intimacy, such as the "affective benefits and costs of communication technologies" (Yarosh et al., 2014). Accordingly, most studies that specifically mention connectedness, social presence or closeness do not measure these variables using reliable measures and primarily use qualitative data from interviews (except a few such as Gooch & Watts, 2010), Even the ones that collect qualitative data, do not always employ validated methods such as thematic analysis or grounded theory to analyse the data (Braun, Clarke, & Terry, 2014; Strauss & Corbin, 1994). Therefore we employed validated measures of closeness and relationship satisfaction from the psychology literature as well as the ABCCT from the HCI literature to measure cost and benefits of the proposed artefacts (Aron et al., 1992; Beatty & Dobos, 1992; Dibble, Levine, & Park, 2012; Yarosh et al., 2014). We also reported the reliability of our other unpublished questionnaires (e.g. connectedness) used in the thesis. We used a mixed method approach to collect qualitative and quantitative data that was analysed by reliable analytical methods such as thematic analysis (Braun et al., 2014). More details about the rationale for these measures are included in respective chapters.

The preliminary studies conducted in laboratories mostly used paper prototypes or working prototypes. In some of these studies, participants were asked to interact with the prototype and then asked a few questions about their experience. Some researchers further asked participants to imagine interacting with the concept of the artefact in a different scenario. Not all of these studies were carried out in the laboratory, and many were conducted in workshops, university's common spaces, exhibitions or museums but in "laboratory mode" where the ideas or artefacts were presented to users and they were then asked their opinions or comments. As mentioned before most of these studies did not carry out formal evaluation and were framed as "pilot tests", and they did not always employ validated measures to gather data. Many of these studies did not provide necessary details about participants. Additionally, the review showed that the evaluation studies employ fewer participants as compared to psychology that tends to use larger population. Small-scale laboratory studies in HCI were done with on average 16 people where longitudinal are done with four pairs (eight people). We, therefore, will be carrying out an in the wild study with the mixed method and with a higher number of participants.

Hassenzahl et al. (2012) suggest the main reason for carrying only preliminary evaluations of these artefacts might be the lack of recourses to create high fidelity

prototypes. It can be extremely difficult to create functional prototypes robust enough to work in the field long enough to collect data that can be analysed and reported professionally. Many of these fiddley prototypes may break down or malfunction during evaluations in the field, and therefore researchers may not be able to gather any meaningful data about the intended interaction with the artefacts. Hassenzahl et al. (2012, p. 14) argues that HCI community quite correctly insist on the evaluation of proposed artefacts yet "The lack of resources leads to favouring easier, more informal ways of gathering empirical feedback, which can be riddled with methodological problems; problems not easily spotted by the same community, which presses for empirical evaluation."

To address this problem and to design technologies that are robust enough to work in the field to collect meaningful data about the interaction, we decided to make use of available off-the-shelf IoT products rather than designing technologies from scratch. There are a number of IoT technologies such as sensors, actuators, RFID tags commercially available which may not be designed for supporting long distance relationships, however, can be used to put together novel ideas robust enough to work in the field. More details about IoT are discussed in section 2.8.

Having discussed methodological issues in HCI and CSCW research around technologies designed for close interpersonal relationship, we now discuss some methodological issues found in psychology literature and challenges with studying parent-adult child relationships.

2.7.4 Methodological challenges in studying parent-adult children relationships

We draw some methodological points from the summary presented in section 2.3 on parent-adult child relationships. The majority of studies e.g., (Chen & Katz, 2009; Gentzler, Oberhauser, Westerman, & Nadorff, 2011; Hofer & Moore, 2011; Mattanah, Hancock, & Brand, 2004; Ramsey, Gentzler, Morey, Oberhauser, & Westerman, 2013; Schon, 2014; Yang, Brown, & Braun, 2013) studied students as their target population. The reason for this is that not only are students an assessable population; they also are going through major changes as a result of moving away from parents. There were very few studies that included a larger age range of groups (see Ermisch, Jantti, & Smeeding, 2012; Lye, 1996) and with those that did include a larger age range, the focus was on relationship characteristics in general and not on technology use. Therefore, we designed our studies to include adult children and their parents without having an upper age limit. We did, however, narrow the scope to people who had access to some technologies, especially internet and smartphones as this was one of the main practical necessities for IoT technologies to work.

The focus of this thesis is on exploring how novel technology can support parent-adult child relationship in terms of emotional connectedness and closeness.

Therefore, we excluded caregiving using technologies which can often be associated with parent-adult child relationships especially in older age (Consolvo, Roessler, & Shelton, 2004; Mancini & Blieszner, 1989).

Analysing and describing the adult parent-child relationship is difficult as the unit of analysis remains a major challenge (Lye, 1996). It is difficult to determine if the unit should be pairs of adult child-parent or only a single parent or adult children. The relationships shared between different parents with the same child or different children with the same parent may have different effects on analysis. Also, some communication may be reported differently depending on the relationship (Lye, 1996).

Most studies in parent-adult children relationship tend to be from one side (Fingerman et al., 2016; Ramsey et al., 2013; Schon, 2014). For example, either they focus on parents asking about adult children or on adult children asking about parents. This is because it can be difficult to deploy dyads of participants. There are few studies that are done on dyads or triads (mother, father and adult child) and even those, as mentioned earlier, focus on emerging adults or college students (Fingerman et al., 2012). In this thesis, we considered the dyad of an adult child and parent for our longitudinal study Chapter 3 and Chapter 5. We also studied both adult children and parents (not related to each other) for the online survey study presented in Chapter 4 which was aimed at recruiting a larger number of participants. Although these parents and adult children were not related to each other, this helped us to gain an understanding of both parent and adult child interaction.

Different definitions of a variable and the use of non-standard instruments in the studies are some of the major gaps in the social science as well as human-computer interaction literature on the family relationship (Carvalho, Francisco, & Relvas, 2015; Yarosh et al., 2014). Various different instruments are used to measure the quality of parent-adult child relationships, for example, scale measures of relationship quality (Amato & Booth, 1991), single variable assessment of relationships quality (Lye, Klepinger, Hyle, & Nelson, 1995), feelings of closeness (Bengtson & Roberts, 1991), intimacy and attachment (Thompson & Walker, 1984) and disagreement (Aldous, 1987). We deployed standardized instruments to measure variables that were of interest in terms of this thesis (e.g. closeness, relationship satisfaction, social presence, connectedness, and frequency of contact.). In Chapter 3, 4 and 5, the methods sections contain more details about the measures and methods used in those studies.

In methodological terms, questionnaires were the most frequently used method to study technology use and feelings e.g. (Madden, Lenhart, Cortesi, & Gasser, 2010; Ramsey et al., 2013; Schon, 2014; Taylor, Funk, Craighill, & Kennedy, 2006), Diary studies e.g. (Fingerman et al., 2016) and interviews, e.g. (Tee et al., 2009) are much less common. Although questionnaires are suitable for concepts such as

relational satisfaction and closeness as they are reasonably constant, they are less fitting for considering concepts which are subject to frequent change, such as feelings of social presence and connectedness which are also addressed in this thesis. In this thesis, we used mixed method approach to collect quantitative and qualitative data. Given that social presence and connectedness fluctuates over short periods of time depending on specific acts of communication, we used diary studies (physical diaries, periodically sent online questionnaires) to assess the volatile nature of these concepts to evaluate technologies proposed in this thesis. These diaries provided us quantitative data as well as qualitative data. We then used interviews at the end of these studies to consider the broader aspects of relational support, suited as they are to probe deeper into the relative area of interest. To understand the use of traditional ICT, closeness, relationship satisfaction and connectedness between parent-adult child relationships, we used online questionnaires to collect quantitative as well as some qualitative data from a larger number of participants.

Interviews, questionnaires and diaries all provide self-reported data; this is advantageous as the data is gathered directly from the people who are being studied. There are, however, disadvantages which are applicable to the various self-report methods. These include: participants may not provide the required level of detail that the study requires. Also, participants may consciously or unconsciously provide incorrect data. Additionally, participants are subject to biases; they can form their opinions based on what others may think or what they think the researcher expects. Also, self-report systems present difficulties in acquiring a truly random sample. Another disadvantage is there can be issues with data consistency, particularly related to primacy (things represented at first are best remembered) and recency effects (most recently presented items will be best remembered). To account for these issues, we use a range of different techniques to ensure that our studies generated data of a satisfactory level of reliability and validity which are discussed in respective chapters.

One way we accounted for primacy and recency effects was by randomising the questions as well as responses to online questionnaires. Additionally, we used mixed methods to collect data in all our studies by collecting quantitative, qualitative as well as system use data. The mixed methods allow the researcher to triangulate the data by using a combination of methods to evaluate the same social phenomenon (Jick, 1979). It has been argued triangulation also serves to validate and verify results arising from different research methods, for example by supplementing qualitative research findings through the application of statistical methods (Tashakkori & Teddlie, 2010). Therefore, a mixed-methods approach supports the internal and external validity of the results (Jick, 1979).

There are limitations within this area of research, which have been acknowledged by other researchers, e.g. (Stafford, 2004). It is the case that most of the effort is focused on white, middle-class, young adult children which also does not take into account

cross-national relationships. Our work does not necessarily correct for these limitations as the participants were recruited using university noticeboards, social media and word of mouth in the south-west part of England which has one of the highest white British population in the country (ONS, 2011).

Although we have been discussing distance and its impact on relationships, there is a factor we have yet to mention: time. “The immediacy of modern communication technologies... highlights one specific factor in long-distance family communication - the time difference"(Cao et al., 2010, p. 155) Having questioned a number of family members living in different time zones, Cao found that despite the difficulty posed by time differences, synchronous methods dominated communication amongst family members. Schedules were an issue, with misalignment of daily schedules being a common problem especially as people were not willing to adjust their own schedule except for special occasions. Unsurprisingly, “people who communicated with their original time zone were generally more effective with the conversion than those (especially parents) who remained in the native time zone" (Cao et al., 2010, p. 157). Cao has demonstrated that these relationships have specific needs and requirements, especially regarding scheduling synchronous communication within both interlocutor’s routine, which although relevant to people within parent-adult child relationships, are less significant to people who live within the same time zone. In this thesis, we include parent-adult child dyads living in different time zones however we do not focus on the differences based on time difference but based on living locations (e.g. living in the same country, living in different country.)

Having discussed methodological issues with studying parent-adult child relationship as well as methodological issues in HCI and CSCW research, we now move our discussion around IoT. In next section, we discuss definitions of IoT, the architecture of IoT, key enablers, some of the applications and the facet to consider while designing IoT systems.

2.8 Internet of Things

This thesis focuses on using the Internet of Things technologies to support long-distance relationships, therefore, it is important to discuss what we mean by IoT technologies. The Internet of Things refers to various objects being connected to each other via some medium. This medium could be wired, wireless or a combination of both. These are objects/things that have a unique identity and can communicate with each other by receiving and sending data. They could have sensors installed in them which are used to gather data about the surroundings and are also equipped with processing power which allows them to make decisions.

There has been a debate about the origin of the Internet of Things term, however according to Kevin Ashton, he first used the term Internet of things in 1999 as a title of his presentation Ashton said, “If we had computers that knew everything... using

data they gathered without any help from us, we would be able to track and count everything, and greatly reduce waste, loss and cost" (Ashton, 2009, p. 1). Bassi and Horn (2008, p. 6) define IoT as "A world wide web of interconnected objects uniquely addressable, based on standard communication protocol". Another definition given by Gartner is that the Internet of Things is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment (Gartner, 2014); this suggests massive amounts of heterogenous objects being connected to each other. There is, however, no one accepted the definition of the IoT. This might reflect the emergent nature of the field and the range of diverse research groups. Most definitions contain highly technical terminologies. We argue that IoT is used as an umbrella term that comprises of identification, sensing, networking, communication, software systems and all connected people and devices; therefore anyone, anytime can use any connected device anywhere they want to access any information they want.

There are almost 23 billion wirelessly connected devices in the market in today; with over 75 billion devices expected by 2025 (IHS, 2018). These devices offer applications in various areas ranging from healthcare, smart homes, education, business and many others. IoT technology allows easy conversion of existing objects into smart objects, which could be used for communication. For example, any object could be given a unique id by attaching RFID tags, by using the Arduino interface, any object can be converted into a touch interface. Kits such as raspberry pie, little bits, Arduino allow easy ways to convert existing objects into IoT enabled communication devices. Koreshoff, Robertson, and Leong (2013) provide a good review of HCI related literature and commercial products of IoT which suggest most of the work is focused on monitoring (e.g. Garden monitoring, medication monitoring, sleep quality monitoring) and tracking (e.g. fitness tracking, location tracking). However, not much research focuses on truly interconnected objects which can support emotional connection between physically distant people.

To date, HCI research has involved pervasive and ubiquitous computing which shares many characteristics similar to those proposed in IoT. Specifically, effort around researching and developing technologies for sensing, tracking, actuating and monitoring has been made. The vision of ubiquitous and pervasive computing proposed by Mark Weiser in 1991 is very similar to vision of IoT proposed by researchers in networking and business in a way that they seek to design technologies which are a "part of the environment, embedded in a variety of everyday objects, devices and displays" (Rogers, Sharp, & Preece, 2011, p. 55). IoT shares many characteristics of tangible and wearable computing researched in HCI that focuses on embedding technologies into everyday objects (Ishii, 2008; Reichl, Froehlich, Baillie, Schatz, & Dantcheva, 2007). However, interconnectivity is an important distinction between these two visions. The vision of IoT proposes interconnectivity between multiple objects and sharing of data between multiple 'things' or resources, creating an ecosystem of interconnected devices. Whereas with

pervasive, ubiquitous, tangible and wearable computing in HCI consists mainly of one device being connecting to one source of data (Koreshoff et al., 2013).

Most of the research carried out in the area of IoT is from technology driven and networking driven approaches. Some of the research involves miniaturization of devices, communication technologies in IoT, unique identification technology (RFID, UID). Some research provides ideas about possible applications however very little research has been carried out to evaluate the interaction. Very few studies have been carried out to explore the usability of these technologies, adaptation and acceptance of them. One of the reasons could be that there are few reports within the HCI literature that directly discuss the IoT (Koreshoff et al., 2013). One of the few was work carried out by Kranz (2010) that analysed embedded interactions in the IoT where the existing objects are used to embed technology to broaden their impact and function. These objects then will be part of the IoT and will be useful to assist users' various ways. An embedded interaction toolkit (EItoolkit) is designed which is an interaction toolkit with software and hardware components that can be used to convert household objects into smart things (Kranz, 2010; Moussette, 2007).

Embedded interaction is different from interaction design as embedded interaction uses objects that are already in use. This creates an invisibility dilemma, which refers to making objects smart without changing their appearance. It is vital to keep the original look and feel the same in embedding these interactions, but at the same time, the user should be able to recognize the added value of these artefacts (Moussette, 2007). Various toolkits are being made to make the internet of things a reality. More and more objects can be turned into smart objects and can be connected using these toolkits.

Despite the significant advantages of IoT over traditional communication technologies, their implementations in the home environment are still very rare (Stojkoska & Trivodaliev, 2017). As with any technology, this could be because of a few issues with IoT regarding technological and social context. Some of the main issues are how to achieve interoperability and compatibility between all connected devices, how to make them 'intelligent', how to connect so many devices, how to make them efficient and scalable while at the same time guaranteeing security and privacy of their users (Heuser, 2008). There has been an effort to address these issues, for example, increased transparency in infrastructure and a large number of encryption methods are being used to ensure security (Atzori, Iera, & Morabito, 2010). Standardization of protocols is proposed to address interoperability (Bandyopadhyay & Sen, 2011; Medaglia, 2010). Yang, Wu, Yin, Li, and Zhao (2017) point out limitations of applying security in IoT devices such as battery problems and computing power. Challenges in the technical implementation of the IoT is not the focus of this thesis, see (Akram, Chen, Lopez, Sauveron, & Yang, 2018; Yang et al., 2017) for recent reviews. All these issues mentioned need to be taken into consideration when designed novel IoT systems.

To alleviate some of the challenges such as battery problems and computing power, appropriation of available technology to design novel systems is recently gaining popularity. For example, smartphones have been proposed as an input device for ubiquitous computing applications as they come equipped with different sensors and features which can be appropriated for different interaction techniques with the environment and with other devices (Ballagas, Borchers, Rohs, & Sheridan, 2006). Excitingly IoT technologies give access to a range of different sensors and actuators that can be embedded in our environment, which provides a huge opportunity for building systems that can connect distant loved ones. Connection to devices such as smart rings, buttons, lights and switches provide designers and researchers with a plethora of opportunities to explore new ways to connect parents and their adult children; however, this area remains significantly underexplored. In this thesis, we take the opportunity to employ devices that can transmit phatic communications connected via a smart phone. This has allowed us to study novel and exciting methods of communication within the parent adult-child relationship which would otherwise not be possible with single device systems.

2.9 Summary

In this Chapter, we discussed the main supporting literature related to this thesis. We have covered what close relationships are, some of the theories around parent-adult child relationships, the importance of studying this relationship as well as the methodological challenges surrounding studying this relationship. We then briefly discussed what connectedness and social presence are and how these concepts may relate to closeness. We then reviewed the various artefacts designed in HCI literature to support close interpersonal relationships. We demonstrated that awareness and expressivity design strategies have been used to create successful devices aimed at supporting close relationships. However not many of them focus on the parent-adult child relationship. By analysing this literature, we were able to find methodological shortcomings in terms of the lack of evaluation and lack of use of validated research methods of these devices. Finally, we discussed the opportunities brought by IoT and proposed using off-the-shelf IoT products to design new systems to support parent-adult child relationships.

To summarize the key findings of this literature review:

- Parent-adult child relationships are important to people's happiness.
- Even when people are separated by distance, maintaining a relationship is important to parents and adult children.
- We have established some methodological points of this thesis; we will
    - Use parents as well as adult children
    - Measure individuals rather than dyads together
    - Will use people that do not live together
    - Will not focus on care for the elderly

- We defined social presence as the feeling of "being together" in that moment and connectedness as the feeling of "being in touch" using technology.
- We established that alongside other concepts, communication media could impact the feeling of social presence and frequency of contact can impact feelings of connectedness.
- We discussed how closeness is important for parent-adult child relationships and that the act of communication could impact closeness in the relationship.
- We discussed how presence using awareness strategy and phatic communication using expressivity strategy could support social presence and connectedness. Therefore we will be employing these two in the designs of our communication devices.
- The designs we propose are not intended to replace the traditional communication methods but are intended to be a supplement a cohesive experience.
- Our analysis of past devices highlighted how only a few devices had been evaluated. We will, therefore, be evaluating the devices we propose in this thesis using longitudinal studies to overcome these methodological shortcomings.
- We also highlighted the lack of proper research methods and use of reliable questionnaires in the evaluations of artefacts. We will, therefore, be employing robust research methods from psychology and reporting the reliability of our questionnaires.
- We then discussed the opportunities presented by fast-spreading IoT technologies, and we will, therefore, be using the off-the-shelf IoT products as components to design novel technologies to support parent-adult child relationships.

These findings suggest that it is necessary to address a number of questions while considering the design of communication technologies to support parent adult child relationships. In next section, we present the research questions addressed in this thesis.

2.10 Thesis research questions

RQ 1: Can Internet of Things (IoT) technologies support closeness and connectedness in distant parent-adult child relationships?

a. **Does the *SmartLamp* and the *ConnectJewellery* system support social presence, connectedness and closeness?**

(This is explored using quantitative measures. See Chapter 3 and 5)

b. **How do distant parent-adult children manage contact over distance?**

(Explored using qualitative data in Chapter 3 and 5. Explored using quantitative data in Chapter 4)

c. **What are people's experiences of using the *SmartLamp* and the *ConnectJewellery* and how do they integrate in their routine communication?**

(Explored using qualitative findings of Chapter 3 and mixed method in Chapter 5)

d. **Is there a relationship between the number of medias used and connectedness, closeness and relationship satisfaction?**

(This is explored in Chapter 4 by exploring the relationship between the number of medias used to communicate with connectedness and closeness in the relationship.)

RQ2: What value does connectedness have for this particular relationship and how does that relate to closeness in the relationship?

a. **Do they desire more connectedness than they actually have?**

(Explored quantitatively in Chapter 4 using a t-test)

b. **Is there a relationship between the connectedness and closeness?**

(Explored in Chapter 4 using correlation and regression and Chapter 5 using correlation)

3 Chapter: *SmartLamp:* Exploring the Effectiveness of an Awareness System to Support Social Presence and Closeness in Parent-Adult Child Relationship

The current study explored whether awareness, created using everyday artefacts situated in one's surroundings, could foster feelings of closeness in parent-adult child relationships. Specifically, whether the use of an asymmetrical awareness system, the SmartLamp, increased closeness in comparison to other media such as email, Facebook and WhatsApp. This simple awareness system was designed and evaluated by appropriating Internet of Things (IoT) objects that are increasingly embedded in our surroundings. A longitudinal study was conducted with six pairs of adults and their parents over a four-week period. The communication behaviours of participants with and without the SmartLamp system were observed. Measures of daily closeness were collected using an adaption of the Inclusion of others in the self (IOS) scale presented within a diary while qualitative data was collected through semi-structured interviews. Results revealed that pairs had more contact during the days they used the lamp and parents reported feeling closer to their distant child. Quantitative data revealed a significant increase in closeness in the first week of using the lamp. Closeness measures on the days the pairs only used the SmartLamp were equivalent to those when they used other media to communicate or met face-to-face and significantly closer than when there was no contact. This study provides evidence that very simple awareness systems can enhance feelings of closeness. The asymmetric nature of the system, the different needs of parents and their children and the use of mobile and wearable applications are discussed.

3.1 Introduction

Children move away from family for a variety of reasons such as studying, finding work or simply growing up and moving away to start independent lives. However, their relationship extends in the adulthood (Mancini & Blieszner, 1989). Studies have shown that parents and their adult children maintain close relationships throughout their lives (Golish, 2000) and approximately 80% adult children report that close and satisfying relationship with their parents(Lawton et al., 1994). The literature review in Chapter 2 noted the importance of parents and adult children's relationships and the lack of research to support this relationship over the distance in human-computer interaction (HCI). Studies of communication and awareness technologies e.g., see (Chen et al., 2006; Dey & de Guzman, 2006; Gaver, 2002; Huijnen et al., 2004; Markopoulos, IJsselsteijn, Huijnen, & De Ruyter, 2005; Markopoulos, IJsselsteijn, Huijnen, Romijn, & Philopoulos, 2003; Neustaedter et al., 2006; Tsujita, Siio, & Tsukada, 2007) directed us towards a role for such technologies in supporting a sense of *relatedness* over distance (Hassenzahl et al., 2012). These studies explored how different technologies could support close interpersonal relationships such as families. Most of these studies focused on general

families and some focus on particular relationships such as romantic lovers, small children and parents, grandparent and grandchildren. However, none of them focused on parent and adult children. Therefore little is known about how they could support this particular relationship. In this study, we explored how awareness technologies may support distant parent- adult children relationships.

Through an asymmetrical awareness system, we probed the design space to explore what value such artefacts may have to support parents and their adult children. We designed and evaluated a simple awareness system, *SmartLamp* by appropriating Internet of Things (IoT) objects that are increasingly embedded in our surroundings (Bassi & Horn, 2008). This study specifically aimed to gain insight into whether these kinds of novel technologies can help to foster a feeling of closeness by creating awareness of distant children in their parents' lives. This is an asymmetrical system where a parent has a small lamp in their home, which is triggered by their adult child's arrival at a specific place. The aim was to understand people's experiences of using the lamp, and whether there is any effect on daily closeness felt by participants when they use the lamp. To this end, we conducted a longitudinal diary study of the in-situ use of technology to mediate awareness and support closeness. The communication behaviours of participants with and without the *Smartlamp* system were observed to understand the experiences of parents and adult children.

We used Social presence (SP), 'the feeling of being together' (Biocca, Harms, & Gregg, 2001) and Closeness which is important relational variable to quantitatively evaluate the system (Dibble et al., 2012). We also used qualitative data to observe the communication between dyads and their experiences with *SmartLamp*. We present our findings of social presence, closeness and experiences of participants using the *Smartlamp* system.

3.2 Background and related work

There has been growing interest in designing and researching novel technologies to support close relationships. We have reviewed the artefacts found in literature, and the detailed review is included in the literature review (see Section 2.7.1). Here we discuss the literature on the awareness strategy of *SmartLamp* System. Awareness is used as one of the strategy to foster the positive feelings in a relationship. Hassenzahl et al. (2012) term these positive feelings as 'relatedness'. They define the concept of 'relatedness' as a feeling of closeness, intimacy, connectedness, and love. Although these concepts are connected, as they are all variables of interpersonal relationships, they all have different meanings. We focus on the concept of closeness, which is a well-established concept in psychology and is one of the most important variables for interpersonal relationships (Aron et al., 1992) and social presence which is a 'feeling of being together', in a way feeling their presence (Short, Williams, & Christie, 1976). We have disused the detailed rationale for using these concepts in the literature review (see Chapter 2). We were interested in exploring if and how

awareness created using everyday artefacts that are situated in one's surroundings could foster feelings of closeness between parent-adult child relationships. In next section, we describe what we mean by awareness devices and some of the previous research done in this area.

3.2.1 Awareness devices

To understand awareness systems, it is important to first understand awareness. Although there are various definitions, in the context of an interpersonal relationship it is defined as, "an understanding of the activities of others, which provides a context for your own activity" (Dourish & Bellotti, 1992, p. 107). Awareness devices provide some peripheral information about another person or of surroundings around the other person to create a presence of the other. Strong and Gaver (1996) were some of the first researchers to place an emphasis on using awareness devices in domestic and social contexts to support intimacy over distance. They designed three objects that explored different senses such as smell (Scent), visual (Feather) and tactile (Shaker) information to convey awareness of distant loved ones. Although these prototypes were never thoroughly evaluated, their work inspired many other researchers and "open[ed] new space for thinking about technology-mediated sociality [and] emphasize[d] the potential for technology to mediate interactions that are indicative rather than explicit, expressive rather than informative, and emotive rather than instrumental" (Strong & Gaver, 1996, p. 30).

Most of the awareness technology fall into the category of ambient design (Ishii & Ullmer, 1997; Wisneski et al., 1998) which aims at beautiful designs and implicit experience. They are not designed for intensive and conscious use that demands the user's full attention. Rather, these artefacts are designed in such a way that they do not need the primary attention of the person using them and are unobtrusive in nature. Also, they fit into the daily routine and do not cause disturbance to the receiver or sender. This is the opposite of other conventional communication technologies such as Skype, phones, emails. Researchers argue that these awareness devices exchange information of the other person or their surroundings to create the feeling of 'relatedness' (Hassenzahl et al., 2012). These awareness devices may transfer information about presence, activity and mood of the other.

The artefacts made for conveying awareness information to create the presence of distant person are significant in close relationships whilst they do not enable users to directly communicate with one another, they have the ability to transfer the feeling of presence. Examples of these devices are transformed everyday objects such as picture frames, mirrors (Dey & de Guzman, 2006). These are presence displays that are to be used by a family or small group of close-knit people contrary to other communication media like an instant messenger that is designed for large groups of people such as friends, work colleagues, relatives and do not necessarily fulfil

requirements that are significant for close relationships. The studies of various presence displays revealed that artifacts that convey presence information create higher levels of awareness and could be beneficial in supporting close interpersonal relationships. These studies, however, did not focus on adult children and parents therefore how they may support this particular relationship is yet to be explored. There were also multiple issues with methods employed in these studies. For example the study by Dey and de Guzman (2006) prompted participants to fill in a questionnaire six times a day in which they actively asked participants to report about the online status of their loved ones which could have biased their findings as by asking participants to look at the awareness device, they were making them aware of the loved ones. We built on their work by employing their principals to our proposed designs.

Artefacts have been made for conveying activity information in an attempt to convey knowledge of daily activities such as each other's schedule or current events or well-being of the other person (Mynatt et al., 2001). Some of the artefacts vary in the level of information they share, for example, *Anemo* is a wind tunnel that connects two spaces by detecting activity in one room by detecting sound. It blows wind in the other room to convey this activity (Ogawa, Ando, & Onodera, 2005). The information of this activity is conveyed artistically or subtly. The authors also proposed another similar prototype called 'air' which was design to communicate "a feeling of presence to a distant partner through light" (Ogawa et al., 2005). The system consisted of two connected lamps, one with blue light and other with red. If the blue lamp is turned on, then the distant partner's connected blue lamp is also turned on and vice versa. The authors present the design of the artefacts and the technical details of the designs however they do not present any user studies. Therefore, the effectiveness of these systems for their intended users is not known.

Tsujita et al. (2007) presented *SyncDecor* that augmented everyday objects to turn them into communication devices. The system included *SyncLamp* (connected lamp) and *SyncTrash* (a connected trashcan system). The *SyncLamp* was a pair of connected lamps designed to share the brightness of light between a romantic couple who are in a distant relationship (Tsujita et al., 2007) For example if a person changed the brightness of their lamp, their partner's lamp would also change in brightness. Similarly, if one partner opened and closed the lid of the *SyncTrash*, the other partner's trash bin also did the same. The authors mentioned carrying out a study with three young romantic couples over the period of three months. The results showed that four out of six of their participants did not feel any significant change in their communication and two mentioned the frequency of contact only increased at the beginning of the study. However, their participants mentioned an increase in their feelings for one another. It is not clear whether the increase in the feelings was because of using *SyncDecor* objects and if so, which object evoked stronger feeling.

The increase in the feeling could also have naturally occurred due to being in a romantic relationship for a longer period of time. The authors reported that the romantic couple felt certain "warmth" while using these systems which they did not feel using traditional communication technologies. Although their work does not focus on parent-adult child relationship, it does indicate the possible value of using everyday artefacts such as lamps to connect distant family members.

All of these devices discussed above were designed with a focus on supporting intimate interactions between romantic partners. Also, many were design ideas and have not been evaluated 'in the wild' therefore it is not known what value these artefacts may have when used in real life. To our knowledge, most of these studies do not provide evidence on how these devices may support other interpersonal relationships such as parent and adult children as the needs of this relationship might be different from those in a romantic relationship.

A work closely related to this study was the *6th sense* developed by (Tollmar & Persson, 2002). *6th sense* was a pair of lamps that responds to movement close to the lamp which then turns on the connected lamp in another person's house. The authors describe a preliminary user study with three families over two weeks. Their findings showed that people felt more aware of the distant family and in some cases, they also reported worrying about the surveillance. Their findings were promising; however, there were a few issues with this study. First, the user had to be in the room and close to the lamp to turn it on. There were several family members that lived in the same household, and the lamp would turn on because of a movement which could be from any person. The authors do not present details about how different users in the household perceived the turning on-off of the lamp. Another issue with this study was the authors deliberately encouraged participants to relate to the lamp by telling scenario before deploying the lamp at their home. The scenario was that "back in the old days when people lived in small villages, they could see their parent's homes by looking out their windows. If the light was lit normally, this was an indicator that everything was fine, or normal" (Tollmar & Persson, 2002, p. 45). The authors also asked participants to call each other and switch on the lamps together when they used it the first time in order to enhance the relationship between the participants. This could have biased the findings of the study as participants may have been reminded of this scenario. Indeed, some of the participants reported interpreting the lamp turning on as things being okay in the other household. The focus of this study was not on parent-adult children relationship. Therefore, how users would naturally use the lamp without researchers associating the lamp with a scenario, how did that integrate with their routine communication and how would it affect specifically the relationship between parent adult children is not known. They do however indicate the potential of using objects at home to connect people over the distance using the

lamp. In this study, we built on their findings to design a system using lamps that allow awareness of adult child arriving at a place.

Interested in parent-adult child communication once the young adult had left their parents' home, van der Hoog et al. discovered that parents do not necessarily miss or need regular conversations but miss moments such as coming home (Keller et al., 2004). Based on their own experience of the problem, they designed a solution an artefact called *Gustbowls,* where a pair of bowl-shaped artefacts were placed in mothers and sons home. The sensors installed in the bowl would take a photo when a key was thrown into the bowl when a son arrives home. The photo is sent to the parent's bowl which shakes as a way of notification. It was not made clear if the adult son noticed parents throwing their keys into the bowl. The authors carried out a one-week case study with a mother-adult child pair. No results were presented which could give details of their experiences. However, the design did demonstrate that devices can be constructed which work with people's existing rituals and behaviour, rather than requiring them to change them. We built on their work by constructing a system called *SmartLamp* that recreates the moments of an adult child arriving at a certain place by switching a lamp on-off at parents' home.

Since conducting the study of *SmartLamp*, some other researchers have also proposed the design of artefacts to connect parents and their adult children using internet of things objects. For example, Soro et al. (2015) designed a prototype of "messaging kettle" which are connected kettles to foster communication with an old friend or relative. The system included a device called *Kettle mate* that is shaped like a kettle and is meant to be situated next to the actual kettle. When a remote kettle is switched on in another house, the *Kettle mate* displays an orange/red show of lights. The system also included a *Tea box* which has a screen (similar to a tablet screen), and a person can draw a message using the stylus. The message is then displayed on the screen of the distant partner's *Tea box.* The authors conducted a pilot study in the laboratory over two-morning teas, first one with five older adult children (in their 50s and 60s) and another morning with six older parents (in their 70s) to test the system. Their findings showed that almost 50% of the participants liked the concept of messaging kettle. However, the need for "design in use" was reported to introduce how to use such objects, suggesting that the design was too complicated for the older user to be used intuitively. Although the authors did not present a detailed evaluation in-the-wild, their findings suggest the need for designing ways to connect parents and adult children living away from each other. Also, their study showed that "habituated" objects, the ones that people already used routinely with a simple form of communication could support this relationship.

Another recent work that was published while our study was in progress was by Davis et al. (2015). They propose a bi-directional system using Philips Hue[1] lights to allow older people to stay connected with their caregiver to reduce loneliness in older people's lives. The authors presented the design to support social presence by detecting and sharing activity and emotion-based information. The authors presented the early prototype of their design along with research questions they plan on exploring, in the future. No evaluation of the artefact was presented. These studies showed, however, the recent growing interest of HCI community in designing or appropriating IoT technologies to connect older parents with their adult children as well as other close people.

Lamps or lights have been used by a number of other studies, e.g., see (Hindus, Mainwaring, Leduc, Hagström, & Bayley, 2001; Ogawa et al., 2005; Suzuki & Hashimoto, 2004; Yasuda, Hashimoto, Koizumi, & Okude, 2007). However, only a few of these have turned conceptual designs into working prototypes, and even fewer have been evaluated (see Appendix A for more details). With the increase of the internet of things, there have been a few recent connected lamps that are available to buy in the market, e.g., (Filimin, 2017; GoodNightLamp, 2016) however to the best of our knowledge there has been no published user evaluation of these artefacts. Also, they were not available at to buy at the time of this study, therefore, could not be employed.

The important condition required for such artefacts to be successful in creating awareness is self-disclosure. Some of the concerns such as privacy, the feeling of controllability and intrusiveness have been associated with these devices. Neustaedter et al. (2006) found that people wanted to be aware of distant loved ones and also feel the duty to be available for loved ones. The level of information about their activity and their status that individuals are ready to share depends on the how close they feel to the other person. Hassenzahl et al. (2012, p. 7) argued that "forcing a certain level of awareness upon couples through a device could lead to a stronger experience of relatedness". Our research aimed to explore what experiences such awareness systems may evoke in parent and adult child relationships.

As discussed in this section, the current research field has demonstrated a strong potential for awareness systems with the research field boasting a wide range of systems designed to support distant family relationships. However, a lot of the research has focused on the design of the artefacts, and there is a lack of detailed and longitudinal user studies to find whether these awareness systems create feelings of closeness. Many studies have been carried out in laboratory settings, which is not a

[1] https://www.philips.co.uk/c-m-li/hue

natural environment for users. Therefore the validity of the results is questionable. Also, as mentioned before, most studies do not focus on parents and adult children. The few that have employed parent and adult children focus on older parents and the focus was on reducing loneliness in their lives rather than the relationship with their adult children. Previous studies on awareness have shown there is a possibility that providing awareness information via other abstract mediums such as light could also foster the feeling of closeness (Huijnen et al., 2004). In this study, we explored if and how an awareness system called *SmartLamp* could foster closeness between parent and adult children by conducting 'in the wild' study with pairs of participants.

Probing the design space using technology:

This thesis has aimed to explore how we can design technologies to support parent-adult children relationship. A few of the previous studies on parent-adult children have been inspired by the own experiences of researchers, e.g., *GustBowl* or *MessageKettle* (Keller et al., 2004; Soro et al., 2015). Although self-experiences serve as an important source of knowledge, they can be only valuable to solve a particular person's need (the researcher). To understand how the artefacts can be designed to cater for a generalised population, we first need to understand their needs. Not many studies have been carried out to understand specific needs of parent-adult children to inspire new designs that might be valuable for this relationship. Given the complex nature of the parent-adult child relationship, it is challenging to learn about their needs by simply interviewing them to ask what they need. To tackle this issue, one of the suitable methods to gather data has been technology probes (Hutchinson et al., 2003).

A technology probe is a tool, an artefact that is deployed in the field for a period of time to understand how users use them. The findings have also allowed researchers to understand the desires and needs of the users to inspire designs of novel technologies further. Technology probes have allowed researchers to collect data about users and the uses of technology in the real-world setting by field testing the technology. The knowledge from the field test cannot only provide data about if and how that artefact could support users, but also inspire designers to think about other novel ideas to support the user (Hutchinson et al., 2003).

One of the requirements of technology probes are technologies that are well-functioning, unlike prototypes that may not have all their features working. These artefacts are simple to use and act as a tool to help determine which kinds of technologies would be interesting to design in the future. Using off-the-shelf IoT devices that are fully functioning has allowed us to design technologies that can work in the field. The *SmartLamp* was therefore installed into a real use context, and we evaluated its use over a period of time. Having discussed previous research, and rationale for conducting in-the-wild studies we present main research question addressed in this study.

3.3 Research questions

The purpose of this study was to design and evaluate a simple awareness system using IoT objects that can easily and effortlessly create the feeling of a connection. This study specifically aimed to gain insight into whether novel technologies such as *SmartLamp* can help to foster the feeling of social presence and closeness in distant adult children and parents. Following are the research questions that this study aimed to explore,

RQ1: Does an awareness technology affect the feeling of closeness?

This research question explored if awareness created via *SmartLamp* had any effect on the daily closeness of parent participant. We used daily closeness ratings reported at the end of the day by parent participants in their daily diary. This research question attempts to answer the overall thesis research question (RQ1a) presented at the end of the literature review (see Chapter 2 Section 2.10).

RQ2: How do traditional communication technologies compare to the *SmartLamp* in the levels of social presence?

This research question explored how different communication media including *SmartLamp* affect the ratings of social presence. To answer this question, we used social presence score reported by parents for different media. This research question attempts to answer the overall thesis research questions (RQ1a, RQ1b) (see Chapter 2 Section 2.10).

RQ3: Is there a relationship between social presence and closeness?

This question explored if there is an association between social presence and closeness. For this, we used social presence score and contact closeness score reported by all participants. This research question attempts to answer the overall thesis research questions (RQ1) (see Chapter 2 Section 2.10).

RQ4: How do parent-adult children maintain contact and how does the *SmartLamp* integrate into that experience?

This question explored how parent-adult children dyads maintain contact by gathering data about their routine communication before they used the *SmartLamp,* during the use of the lamp and after they stopped using the lamp. The qualitative data from diaries and interviews were used to understand how the *SmartLamp* was integrated into their routine communication. This research questions attempts to answer the overall thesis research questions (RQ1b, RQ1c) (see Chapter 2 Section 2.10).

3.4 Method

3.4.1 Participants

Participants were recruited through word of mouth advertising at the University of Bath and REACT hub in Watershed Bristol. Eight pairs of parent-adult children signed up for the study. However, six pairs completed the entire study. The two pairs that dropped out completed the phase one where they filled in the diary for one week which provided details of their daily communication. One of these pairs also carried out a few days of phase two where they used the lamp in addition to the phase one. The incomplete diary data of these two pairs were not included in the quantitative analysis, however; parts of their interviews were included in the qualitative analysis as they gave insight into their use of ICT to maintain their relationship. Out of the six pairs (12 participants in total) that finished the study, three pairs were mother-daughter, two were mother-son, and one was father-daughter. Adult children's' age ranged from 21- 38 years and parents' age ranged from 50 – 62 years.

3.4.2 Design

We chose to construct a longitudinal study around diary based self-report activity from pairs of parent-adult children. The deployment of *SmartLamp* in the real world rather than in the lab should enable more naturalistic data collection. A single lab study would not enable us to see how *SmartLamp* is used in participants' daily routine. Therefore, we chose to do a diary study for four weeks.

The study used a mixed method approach to gather data. Quantitative data of closeness and social presence was gathered when participants communicated or used the lamp. Qualitative data was gathered to understand the communication routines of participants and their experiences of using *SmartLamp*. There were two main sources of qualitative data: the semi-structured interviews at the end of the study and the free-text component of the diary where participants were asked to write their thoughts at the end of the day. We asked people to choose one of their parent or adult children that they are most in contact with and who would be happy to take part in the study.

The study was conducted over a one-month period. The study consisted of three phases.

- **Phase 1:** This was the first week where the ordinary communication routines of participants were observed via a diary.
- **Phase 2:** This phase consisted of 2 weeks where the *SmartLamp* system was installed at the parent participant's home. Pairs were asked to continue filling out the diary during this time.
- **Phase 3:** This was in the last week of the study when the system was un-installed from the parent participant's house. Participants continued to fill in the diary in this phase to observe if there was any change in the communication habits and daily closeness of participants after they stopped using the lamp.

Diary design

We recruited six dyads of participants, and the study required all dyads to keep a diary that had two sections. Each used a different sampling method to account for the temporal differences in feelings of social presence and closeness we have discussed in the literature review Chapter 2. The study was asymmetrical, that is only parents had the lamp in their home. Therefore the parents' diary included some questions about the *SmartLamp* in phase two. This was different for adult children who did not use the lamp. For phase one and two, diaries were the same for both participants. The diary pages are included in the Appendix B Section 9.5. As we wanted to investigate changes in social presence and closeness over time, we used a periodic self-report method. The first section was event based; it was completed each time the participants had contact with each other. Participants were asked to complete their diary as soon after a communication event as was practicable. Each entry recorded basic information about the communication act including date and time, method of communication, device used and their feeling after the contact. Participants were asked to complete measures of social presence and closeness. In this section closeness is referred to as a contact closeness; the closeness that is experienced at that moment. This data allowed us to explore the relationship between social presence, which is a temporary feeling of "being together" and closeness felt at the moment of that contact. This data also allowed us to measure social presence rating of that medium. Participants were instructed that:

"This section is intended to record your communication with your study partner each time you contact (or are contacted by) your study partner. Every time you communicate with your study partner, please fill in a new record. There are a few simple questions about the contact. After that, there is a table that consists of 9 items. Please choose how you would best describe your exchange of communication. Please rate how you would describe the contact."

The second section of the diary was filled in at the end of the day regardless of whether there was any communication or not. It included a measure of closeness that is the inclusion of others in the self (IOS) scale that participant completed at the end of the day. This section also included a question that asked participants to write about how they felt about their study partner that day if they communicated or not and how it made them feel. They were asked to report if there was anything unusual about their communication. This data allowed us to understand the factors that might have impacted on their contact. This data also allowed us to understand if there was a change in the closeness felt by parent participants from before they use the *SmartLamp*, during the use of *SmartLamp* and after they stopped using the system. Participants were told the following:

"Section 2 is intended to record how close you feel to your study partner. Please fill this part in in the evening preferably at the same time each day. Please circle the

diagram which best represents how close you feel to your study partner. The circle tagged as self-refers to you, and the other refers to your study partner.

At the end of section 2, there is a free-form component where we would like you to write any comments you have about your daily communication habits and Smart lamp system. We want to know whether you used it or not, what impact did it make on your daily communication routine."

Material

Participants were given a WeMo switch, a diary, a pen and return pre-paid post envelope. They were given the option of either using their own lamp or a small lamp was provided for them. All of the participants chose to use their own lamp that was already part of their home furniture. WeMo[2] mobile app and IFTTT[3] mobile app was installed either by the leading researcher, or they were guided how to install and connect these applications using Skype, telephone or in person.

The diary included measures of Social presence and closeness which are discussed below. At the end of the study, participants were invited to attend a semi-structured interview.

Measures of Closeness:

The Inclusion of others in the self (IOS) scale was used in this study to measure closeness in the relationship (Aron et al., 1992). This is a graphical Likert scale, which has seven graphical images that have two circles, one representing self and the other representing the study partner (see Figure 3). The diary included a question in section 1 and section 2 asking participants to choose the image that best describes their relationship. The end where circles are completely separate represents not at all close, and the other end where the circles are almost overlapping represents extremely close. The options represented various degrees to which participant feel close to their study partner. The score was between 1 to 7 where one accounts for minimum closeness and seven accounts for maximum closeness.

The reason for using this closeness measure was it was validated and takes less time to fill in compared to other validated closeness measures such as URCS, RCI (Berscheid et al., 2004; Dibble et al., 2012). As we asked our participants to fill in the diary every day, it answered the research question and was realistic to complete every day.

[2] http://www.wemo.com/

[3] https://ifttt.com/

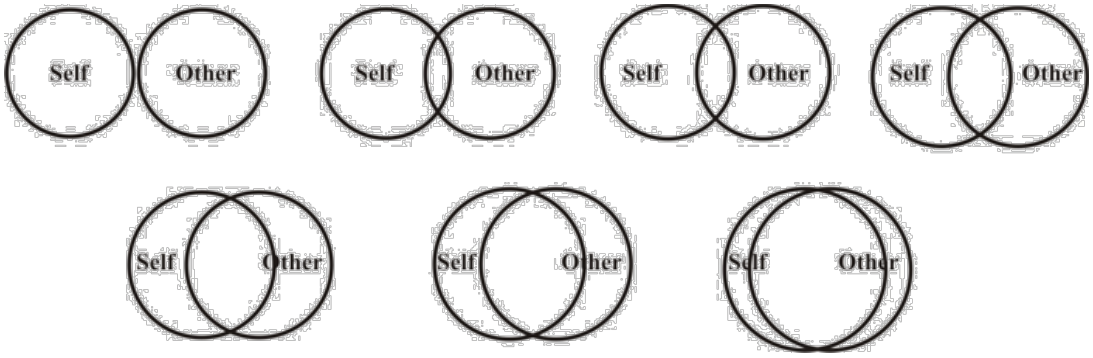


Figure 3. Inclusion of the others in the self (IOS) scale (Aron et al., 1992)

Measures of Social Presence:

There are a number of tools developed to measure social presence; however, there is no one accepted a measure of social presence. Some measures such as Networked mind (Biocca et al., 2001), CMC questionnaire/Social presence and privacy questionnaire (Tu, 2002), GlobalEd questionnaire (Gunawardena & Zittle, 1997) are quite long to fill in. Also, they are focused on a particular type of systems, e.g., eLearning/educational systems therefore not appropriate to evaluate an awareness or communication technology. We needed participants to fill in a social presence measure every time they had contact with their study partner. The participants could have multiple contacts during the day therefore long questionnaires were undesirable.

We chose the semantic differentials measure which is developed by Short et al. (1976) as this is the shortest and was developed to evaluate communication systems. The semantic differential by Short et al. (1976) considers social presence as a property of communication media.

	3	2	1	0	1	2	3	
Impersonal								Personal
Cold								Warm
Ugly								Beautiful
Small								Large
Insensitive								Sensitive
Colourless								Colourful
Unsociable								Sociable
Closed								Open
Passive								Active

Figure 4. The semantic differentials measure of social presence (Short, Williams & Christie, 1976)

The participants were asked to rate each communication medium on a bi-polar scale including personal, impersonal, cold warm sensitive-insensitive. They contained nine

diametrically opposed adjectives (see Figure 4). Ratings were made on a seven-point Likert scale from 3 (near one adjective) through to 3 (near the other adjective). These were then counted as being between 1 and 7 before being summed to give a single measured response.

The meaning of the differentials focuses on the medium (e.g. `Skype VOIP is impersonal vs personal') and so is implicit in the way they evoke the sense of the other person (Biocca, Harms, & Burgoon, 2003). The scales' use of nine pairs means that the burden of completing the SP ratings is small- an important element of a longitudinal study that seeks to record assessment close to the relevant event. In this study, we reported each score as a sum of a participant's ratings of the nine semantic differential items (max score was thus 9 x 7 = 63, the minimum was 9 x 1 = 9).

Qualitative data gathering

Addition to the measures above, participants were encouraged to complete a free-form entry at the end of the day. Participants were prompted with the following talking point,

"How do you feel about your study partner today? If you communicated with your study partner today, how did it make you feel? Did the feeling last all day? Was there anything unusual about your communication today?"

A Semi-structured interview was conducted at the end of the study with all participants to gather more qualitative data. This was either conducted face to face or via Skype with the distant participants. Following questions were used to guide the interview:

General Questions:

- What do you miss the most in the distant relationships with your study partner?
- Which medium do you prefer using to communicate with your study partner?
- Why?
- What do you like about that medium?
- Which medium do you least prefer to use to communicate with the other person?
- Why?
- What do you dislike about it?
- Have you changed your communication habits since this study began?
- (if yes) How did it change?

Questions about the lamp:

- What are your first thoughts on the lamp system?
- Do you think this is a system you might or might not use? Why/why not?
- What do you like about the concepts behind the lamp system? Why?

- What do you dislike about the concepts behind the lamp system? Why?
- Do you think the lamp system impacted on your communication habit?
- If yes/no- what way?
- Did this system make you feel aware of your study partner? Why/why not?
- What do you think about the way the device is activated?
- Can you think of any other way of using it?
- What would you like to add or remove from the system?
- Is there anything else you would like to tell us about the device?
- How do you feel after not using the lamp system for past one week?
- Has it changed your communication routine? In what way?

The interviews were audio recorded and transcribed by the primary researcher. Thematic analysis was carried out on the transcripts by following six phases described in Braun et al. (2014),

1. Familiarizing with data
2. Generating initial codes
3. Searching for themes
4. Reviewing themes
5. Defining themes
6. Naming themes
7. Producing the report

The analysis began by reviewing printed transcripts and inductively generating initial codes. The recurring themes were identified, and a thematic map of analysis was generated. The interviews investigated whether the participants' perception supports the quantitative data generated by the IOS scale as well as the experiences reported by participants when they used the lamp. This data helped us understand how people communicated with each other, technologies they used for maintaining relationships as well as how the *SmartLamp* was situated in their daily life.

3.4.3 Design of the device

In this research, we argued that there is an opportunity to appropriate connected household artefacts enabled by IoT, to support connection with distant loved ones. This study used an off the shelf home automation device called Belkin WeMo switch (see Figure 5) and a mobile application called If This Then That (IFTTT). The Belkin Switch is intended for the control of home electronics, and the IFTTT app enables various applications and IoT devices to communicate and work together. In the *SmartLamp* system, the WeMo switch was provided to parents, and a small lamp was plugged in the switch. The switch was connected to parent's home Wi-Fi and used the Internet to connect to their distant adult child's smartphone. The smartphone of the adult child used GPS to locate enters/exits from a particular place and triggered the WeMo switch in parents' house. Entering a particular location triggered the switch to turn on and exiting the area to turn off. The process can be seen in Figure 6.

Figure 5. A Belkin WeMo, lamp and the diary provided to participants.

Figure 6. Process: GPS Location detects enters/exits of adult child -> IFTTT Triggers WeMo switch at parents' house -> Lamp turns on/off

The *SmartLamp* was an asymmetric system, and only parents were given the lamp to use in their home. The design of the *SmartLamp* was inspired by the notion of recreating experiences of living together by providing awareness of the others routine activity. When people live together, they are aware of each other's daily activities such as coming and going. This experience is created automatically. *SmartLamp* tried to recreate such experience with geographically distant families. It enabled users (the adult child) to let their parent be aware of their activity of arriving at a particular place automatically. The adult child could decide a designated place that was meaningful to them, and when they arrived at that place, the lamp was

automatically switched on at their parents' house. When they left that place, the lamp was turned off. Once installed, this system worked automatically, without users' needing to perform a conscious action, hence creating a more natural experience of arrival/leaving. The idea behind the concept was to afford the parents with an ambient awareness of the distant child's routine and to explore the efficacy of this awareness for enhancing closeness.

We used the IFTTT app that enabled pairing of a WeMo switch with the location of the smartphone of an adult child to reduce firstly, the physical effort of using mobile phones/landline phones to dial and make the call or to log in to the computer or smartphone to explicitly send a message to the parent. Secondly, to reduce the mental effort of remembering to make contact. It is worth noting that we do not suggest that making systems that are effortless are necessarily better, it has been recognized that effort is appreciated in communication (Gooch & Watts, 2011a; Kelly, Gooch, Patil, & Watts, 2017; King & Forlizzi, 2007) however there are instances where a person may not desire or need to communicate yet may want to keep in touch (say hello) to create a connection (Kuwabara et al., 2002).

3.4.4 Ethics:

We were working in an area where it is particularly important to consider the ethical implications of our study. Ethical approval for this study was granted by the University of Bath, Department of Psychology Ethics committee, Ref: 15-096. Included in Appendix B (see Section 9.1 and 9.2 and 9.3) are the ethics forms, information sheet and consent form that were submitted to the ethics committee.

To briefly run through the main concerns; the study included no hidden procedures, and no deception was involved. Participants were informed about the data being collected, and it was made clear that it would be recorded anonymously and could not be traced back to the individual. It was made clear to all participants that the adult child's GPS coordinates were captured and sent over to the WeMo switch to turn on the lamp at their parents' house. It was also made clear that the data would not be passed to any third party (including their study partner) and were not being collected for commercial reasons. However, participants were warned that the *SmartLamp* system is not reliable and they should contact their study partner in case of any concerns about their whereabouts. They were also told that the results of the study would be published in an anonymous form.

It was made clear in the consent form that participation in this study did not involve physical or mental risks outside of those encountered in everyday life. Most importantly, it was made clear that participants had the right to withdraw from the study at any time. Informed consent was taken from all the participants before the beginning of the study.

3.4.5 Procedure

The participants were asked to fill in the diary at the end of the day regardless of whether there was any communication or not. It included a measure of closeness that is the inclusion of others in the self (IOS) scale that participant completed at the end of the day. This section also included a question that asked participants to write about how they feel about their study partner, if they communicated or not, which technology they used and how it made them feel and if there was anything unusual about their communication. This data allowed us to understand the factors that might have impacted on their contact. Also, if there was a change in the closeness felt by parent participants before, during and after they use the *Smartlamp*.

1. A few days before the study, the researcher met with participants either in person or via Skype. The study was verbally explained to participants. They were provided with an information sheet, and after answering all the queries if the pairs were still happy to participate, they were asked to read and sign the consent form. All the parent participants were given aWeMo Switch, a consent form, a diary, and a pen. For participants living far away from Bath, these were sent by post, and a pre-paid return package was provided with the pack. Some of the participants were guided in person and others via Skype on how to install the if this then that (IFTTT) app and how to configure it with Belkin WeMo switch. For other participants that were not tech savvy, the researcher installed the WeMo Switch and app with the participants' permission. All the participants were asked to contact the researcher if they had any issues while the study was running, and these were solved via either Skype, telephone or in person by the researcher.
2. The *SmartLamp* system (consisting of IFTTT app and Belkin switch) was tested but not activated.
3. All participants completed phase 1 after signing the consent form and reading the information sheet. Phase one did not involve using any new technology and was to observe the normal communication routine of the dyads.
4. On the last day of the first week, participants were informed that phase 1 was over.
5. For Phase 2, *SmartLamp* was activated, and participants were asked to fill in the diary as they had in phase 1. Parents were asked to note their thoughts about the lamp activation, the system or their communication at the end of the day.
6. On the last day of week 3 (at the end of phase 2), the participants were informed that it was the end of phase 2.
7. On the first day of week 4 (at the start of phase 3) the *Smartlamp* system was uninstalled, and the participants were asked to continue to fill in the diary as they did in phase 1 and 2.
8. At the end of the week 4, they were asked to stop filling in the diary and return the material either by post or it was collected in person by the researcher.

9. All participants were invited to attend an interview that lasted between 15 to 30 minutes. Participants attended the interview either via Skype, telephone or in person.

3.5 Results:

Our 12 participants returned a diary each, for a total of 12 diaries. Their daily diaries included ratings of daily closeness, social presence for each media, if they communicated with each other, what ICT they used, a short description of what the contact was for and how it made them feel and if there was anything unusual about their contact that day. The quantitative data were analysed using statistical methods such as a one-way ANOVA or Welch ANOVA for determining if the differences in the level of daily closeness differed significantly depending on the phase of the study. A Spearman's rank order correlation test was carried out to explore the relationship between social presence and closeness.

3.5.1 Quantitative results

Participants reported using multiple media to contact one another. The different media included: SMS, telephone, emails, instant messages, video/audio calling (using Skype/FaceTime), letters and social media (such as Facebook wall posts /comments). The diary showed that all pairs used a minimum 3 to 4 different media during the study. However, one main preferred media was used for most of the communication with other media used only if needed. The most popular were instant messaging apps such as WhatsApp or Facebook messenger. Four out of six pairs said instant messaging was their main way of connecting to one another. Quantitative data was used to answer the first three research questions, and the results of them are presented in this section.

RQ1: Does an awareness technology affect the feeling of closeness?

RQ1 examined if and how this specific IoT system, *SmartLamp* affects the feeling of closeness. The data of the daily closeness reported by parent and adult children throughout the three phases were used for this analysis. Phase 1 where they did not use the lamp (week1), phase 2 where they used the lamp for two weeks (week2 & 3) and phase 3 when they stopped using the lamp (week4).

Table 2 and 3 shows the mean daily closeness and standard deviation for all four weeks for parent's data and adult-children's data respectively. A one-way ANOVA was conducted to determine if there was any difference in closeness over the three phases. The mean closeness of each week was calculated for all four weeks.

For parent's data, there were no outliers, as assessed by boxplot; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$); and there was the homogeneity of variances, as assessed by Levene's test of homogeneity of

variances (p = .621). Data is presented as a mean ± standard deviation. The daily closeness of parents was significantly different over the 4 weeks, F (3,168) = 3.937, p = 0.01, partial η2 = .066. The daily closeness increased significantly from week 1 (n= 42, 3.45±2.08) to week 2 (n= 47, 4.63±1.98) and gradually decreased from week 2 to week 3(n= 46, 4.34±1.81) to week 4 (n= 37, 3.54±1.09). Tukey post hoc analysis revealed that there was a significant increase in closeness from week 1 to week 2 (1.186, 95% CI (0.11 to 2.26), p= 0.024) but no other week's differences were statistically significant.

Table 2

Mean Daily Closeness of Parents over Four Weeks

Week	N	Mean	Std. Deviation
Week1 (No Lamp)	42	3.45	2.08
Week2 (With Lamp)	47	4.63	1.98
Week3 (With Lamp)	46	4.34	1.81
Week4 (No Lamp)	37	3.54	1.9

For adult children's data,
There were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test (p < .05); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out one-way ANOVA was considered appropriate. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .478). The daily closeness of adult children was not significantly different over the four weeks, F (3/157) = 0.802, p = .494.

Table 3

Mean Daily Closeness of Adult Children over Four Weeks

Week	N	Mean	Std. Deviation
Week1 (No Lamp)	42	3.43	1.27
Week2 (With Lamp)	41	3.80	1.23
Week3 (With Lamp)	44	3.68	1.09
Week4 (No Lamp)	34	3.76	1.23

Upon observing raw data, there were differences in the daily closeness of parents' data on the days when pairs used ICT to contact each other compared to the days they used the lamp or had no contact. Therefore, we analysed the daily closeness reported by parent participants on the days they had a contact- using a lamp, some

ICT media, face to face and on the days they had no contact. The days were divided into five following categories,

- F2F: This is closeness on the day's pairs met face to face
- ICT: This is closeness on the day pairs had contact using some ICT
- Lamp: This is closeness felt on the day pairs had contact only using *SmartLamp*
- ICT+ Lamp: This is closeness on the day pairs used *SmartLamp* as well as contacted using ICT
- No contact: this is closeness on the day pairs had no contact with each other

A one-way ANOVA was conducted to determine if there was any difference in closeness between the five different conditions. There were no outliers, as assessed by boxplot; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$); and there was homogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p = .119$). Data presented as a mean ± standard deviation. The daily closeness increased from no contact (n=46, 2.11±1.54) to ICT (n=47, 4.45 ± 1.83) to Lamp (n=28, 4.64±1.52) to ICT+Lamp (n=33, 4.91±1.63), to F2F (n= 18, 5.33±1.37), in that order. The daily closeness reported by parents was statistically significantly different for these five different conditions, F (4, 167) = 23.246, $p < .001$, partial η2 = .358. Post hoc comparison using the Tukey HSD test indicated that the mean score for the Lamp only ($M = 4.64$, $SD = 1.52$) was significantly higher than No contact days ($M = 2.11$, $SD = 1.54$) ($p < .001$). The score of No contact was also significantly lower than F2F ($p < .001$), ICT ($p < .001$), and ICT+Lamp ($p < .001$) However, the Lamp condition did not significantly differ from ICT, F2F and ICT+Lamp conditions.

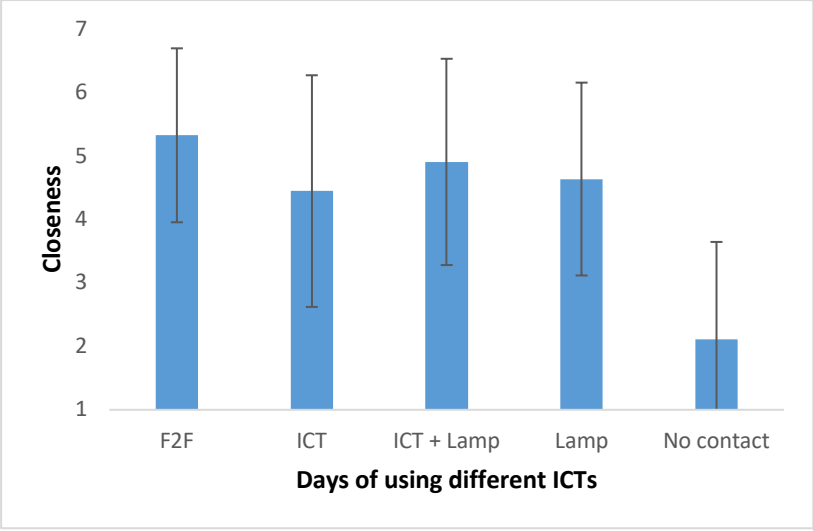


Figure 7. Parents' mean daily closeness for different conditions. Error bars show standard deviation

Figure 7 shows that on the day's pairs had some contact, the closeness felt by parents was statistically significant compared to the days they had no contact. The closeness on the days that pairs met were the highest. It was interesting that the closeness on the day's pairs had contact using traditional ICT was similar to the days they only used *SmartLamp* suggesting that the ambient awareness created by lamp turning on/off could foster the feelings of closeness as strong as when contact using ICT was made. The sense of connection created by awareness of activity of their son/daughter may have contributed to making parents feel closer to them.

RQ2: How do traditional communication technologies compare to the *SmartLamp* in the levels of social presence?

RQ 2 examines whether the type of communication media affects ratings of Social presence. It was analysed using the social presence ratings reported by participants after each communication act.

Table 4 describes the different communication media used by the parent and adult children participants during the study and the mean social presence score of each media. Nine different media were used by participants to maintain the contact. It is important to note that not all nine media were used by all participants. The number of medias used by each pair ranged from 3 to 4. As can be seen the Table 4, video chat interactions were reported with highest SP score and instant messenger received lowest SP score.

Table 4

Mean and Standard Deviation of Contact Social Presence Score for Each Type of Communication Media Reported by All Participants

Media used to contact each other	N	Mean	Std. Deviation
Video (Skype/FaceTime)	14	48.21	6.705
Letter/Package	1	47.00	-
Telephone	26	42.19	12.796
Lamp	61	41.77	3.546
Face-to-face	38	40.87	14.128
Social Media (Post/Comment)	10	40.26	13.036
SMS	31	39.52	3.075
Emails	35	36.87	10.770
Instant messaging	111	33.92	16.985

Only two parent participants provided SP score for the *SmartLamp* although all six used the lamp. Therefore, we compare the SP score provided by these two participants for different media used by them to contact their adult children (see Table 5).

There was one outlier for the lamp condition, as assessed by boxplot which was omitted for analysis. The data violated the homogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p < .05$). Data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples. Therefore, carrying out Welch ANOVA was considered appropriate to compare the effect of type of media on social presence in all seven conditions. There was a significant effect of type of media on social presence at the $p < .05$ level for the seven conditions [F (6, 122) = 4.5, $p < .001$, partial $\eta 2 = .181$)]. Post hoc comparisons using the Games-Howell test indicated that the mean score for the SMS (M= 39.00, SD= 1.58) was significantly lower than Instant messaging (M= 46.16, SD= 8.27, $p < .05$), Face to face (M= 42.80, SD= 2.29, $p < .01$) and *SmartLamp* (M= 41.77, SD= 3.54, $p < .001$). The difference was not significant between the other conditions ($p > .05$).

Table 5

Mean and Standard Deviation of Contact Social Presence Score for Each Type of Communication Media Reported by Parent 1 and Parent 3

Media used to contact each other	N	Mean	Std. Deviation
Instant messaging	19	46.16	8.274
Telephone	4	45.25	8.015
Social Media (Post/Comment)	6	44.33	3.386
Face-to-face	10	42.80	2.299
Lamp	62	41.77	3.546
Emails	16	40.75	3.087
SMS	13	39.00	1.581

RQ3: Do levels of social presence relate to closeness in a relationship?

To answer RQ3, social presence ratings and closeness ratings reported by all participants after each communication act were observed. Spearman's rank-order correlation was run to determine the relationship between social presence ratings and

contact closeness rating reported by all participants for four weeks. There was a strong, positive correlation between the social presence and contact closeness, which was statistically significant r (325) = .408, p <.001.

3.5.2 Qualitative analysis

To answer research question 4, we analysed the qualitative data from diaries and interviews.

RQ4: How do parent-adult children maintain contact and how does the *SmartLamp* integrate into that experience?

All participants' interviews took approximately half an hour. In addition to the interviews, we also had notes of participants from their diaries. A thematic analysis was conducted using six steps explained in Braun and Clarke (2014). This qualitative data is presented below as direct quotation from our participants. We explored how pairs maintained relationships with each other over the distance and how the *SmartLamp* system was used in their daily lives.

Three themes were identified from the thematic analysis which is explained in this section. Figure 8 shows all main themes with their subthemes. The Main three themes were 1) Managing contact, 2) Benefits of *SmartLamp* and 3) Costs of using *SmartLamp.*

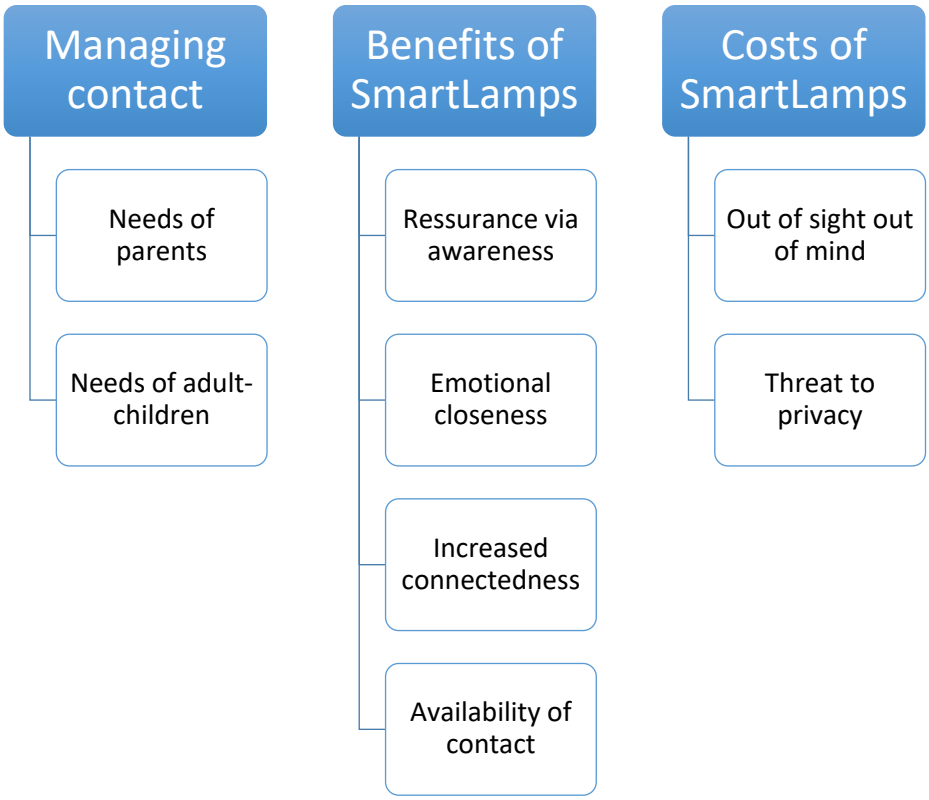


Figure 8. Themes and subthemes from qualitative analysis.

Theme 1: Managing contact

This theme encapsulates how pairs managed their communication and their contact needs. There were distinct differences in relational as well as communication needs of parents and adult children which are presented below.

Subtheme 1.1: Needs of parents:

All parents mentioned desiring more connection with their son/daughter. The contact with their son/daughter is of great importance, and parents valued being in touch with their adult children. One of the mothers mentioned being fond of the sound of received messages on her mobile devices from her adult children,

> *"I just like it when the messages ping in; it's a lovely feeling knowing someone you are close to, messaged. That sound is always an indication that someone is in touch with me that I like" P1*

Although all six parents mentioned wanting more contact, most of them assume their children may be busy, and they hesitate to make contact for fear of disturbing them. Some parents also recognise that their needs for connection are greater than their son/daughter may want. They recognised that although they desire more connection, it is important to maintain some distance. For example, a mother said in the context of all her children,

> *"I do really love contact with my children and well it's a difficult balance because I would be happy to have contact with them every day but I know they have busy lives and my need would be too big a demand on them…. [] …. I also know that I have to step back and let her lead her own life……it's a difficult balance that you strike with an adult child. I think the parent needs are always more … [] ... It's harder letting go, but it's important to let go." P3*

Two of the parents mentioned feeling frustrated and less close to their son/daughter when they sent messages or called them, but their son/daughter did not reply. For example, a mother wrote in her diary that she felt upset when she sent her son a message but did not get a reply,

> *"My WhatsApp was not answered although I could see it had been read. He was logged into Facebook…..[] …. Although I said fine as the day went on and no answer and the lamp was not activated, I was slightly angry and anxious, but that's sons for you! I am not chasing around as he is 38!!" P5*

Subtheme 1.2: Needs of adult children:

Although the adult children felt they want to maintain contact with their parents, they did not always reciprocate the feeling of wanting more communication. Four out of the six adult children participants indicated that their parents would talk 'too much' on the phone so they preferred using communication channels over which they had more control, such as Messenger instead of the telephone, or the telephone instead of Skype. For example, one daughter stated,

> *"I may speak to her [mother] on the phone, but then I have to... um... It's more difficult to get rid of her (Laughs). Does that sound mean? Like on Facebook it's easy to go like 'Okay I will go bye' and stop talking" AC6*

Another daughter mentioned similar feelings and said the reason for avoiding using Skype and opting for the telephone to contact her parents was that she could do other things and did not have to give focused attention while conversing with her parents,

> *"I think, (laughs) this sounds bad, umm.. Sometimes my parents talk about things too much so I like being able to do things at the same time as talking about them because they repeat the same thing over and over again, so I can be half there and half not. Awful daughter! (laughs)"AC4*

However, adult children nonetheless like to maintain some connection with their parent, especially knowing that they are all right. Most son/daughters recognised the importance of making contact with their parent. Also, they felt there was a duty of being in touch with their parents, and they felt a sense of guilt for not staying in touch with their parents as much. For example, a son mentioned he feels he should call his mother more often as he knows she likes it; however, he leads a busy life,

> *"Not as often as I should. That's because I am busy, and I find myself, oh I haven't phoned her for a while, so I should phone her... I think it's just that she appreciates me phoning her." AC5*

The older adults reported being quite comfortable with living away from their parents, having lived like that for many years. However, they missed receiving support such as practical help or emotional support. A daughter that has her own small children mentioned that she misses,

> *"Childcare help! (Laughs) I guess I just the sense of having someone looking after you. I guess as a parent I am very much grown up in my house, so it's quite nice when I am with my parents that it still feels like they are the grown-ups and that they want to look after me. Umm… yeah" AC3*

The findings from adult children data complemented the findings from their parent's data. The parent's need seemed to be more than their adult children, and most parents recognise that. Both, the parents and their adult children try to find the right balance of maintaining the contact and keeping some distance. Parents want more connection without being intrusive, and adult children want to 'keep in touch' yet do not/cannot constantly communicate with their parent. They do not, however, want to let the parents feel neglected and seem to carry guilt if they did not contact their parents for a while. Adult children may feel a sense of obligation to maintain contact out of parents need for more contact.

Theme 2: Benefits of SmartLamp

Participants mentioned some benefits and some costs of using the *SmartLamp*. This theme encapsulates the benefits reported by parents when they started using *SmartLamp.*

Subtheme 2.1: Reassurance via awareness

All of the parents of adult children mentioned feeling more aware of the son or daughter who participated in this study. For example, a mother mentioned,

> *"Yes, it did make me more aware of him, definitely yes because I have two sons so noticed the difference, I usually think about both of them, but it did make me more aware of this one." P2*

All parents reported feeling reassured when the lamp switched on in the evenings, indicating that their son/daughter had arrived home safely. Parents mentioned feeling 'happy and relaxed' when the light switched on; it was 'comforting' and 'amusing'. They mentioned feeling relaxed that their son/daughter was at home and safe. When the lamp switched on/off, they could visualise their son/daughter,

> *"It [SmartLamp] is very reassuring, settling etc. when it turns on and since we have visited AC4 [daughter] plenty of times, it is lovely to be able to visualise her in her home environment where we know she is safe and happy." P4*

Similarly, the adult children reported that they would like to know that their parents are safe and well,

> *"I guess just seeing her [mother] and knowing that she is alright." AC4*

This suggests that the *SmartLamp* could be beneficial not only for parents but also for adult children to know the wellbeing of each other.

The lamp overall created a positive feeling for the parents. A mother wrote in her diary,

> *"It was nice in the evening as we were out and when we got back, it [lamp] was on. This made me feel good." P5*

Subtheme 2.2: Emotional closeness

Five out of six parents mentioned feeling more close to their son/daughter when they used the *SmartLamp*. For example, a mother mentioned she felt closer to her daughter when she saw the lamp was on,

> *"When it was switched on, I felt relaxed, and I knew she was home and safe umm... I was just happy to know she was home really and felt close to her..." P4*

Another mother mentioned feeling a fleeting closeness because of the awareness by the lamp,

> *"It made me smile really (laughs) if I saw it on. You know I was sort of 'Oh right, she's there'. And um… Yeah, I think you feel closer in a sense for a few minutes you know." P6*

Three parents reported forming an emotional connection with the lamp as a reminder of their son/daughter. For example, a parent said,

> *"I miss the lamp system; sometimes I find myself looking at the lamp wanting it to switch on. It was a nice, warm experience and I enjoyed doing it." P2*

Another mother mentioned,

> *"I think in a strange way I am going to miss the lamp! We have had some funny conversations as a family and seized quite a few comments." P5*

In a way, some parents started seeing the lamp as a proxy for their distant son/daughter to satisfy their emotional needs.

Subtheme 2.3: Increase connectedness

Pairs had more contact in the days they used the lamp. A number of reasons were articulated. For example, turning on/off of lamp prompted some parents to contact their son/daughter. For example, a son mentioned his mother contacted him just after he had left for work,

> *"There were a couple of times it was funny because my mum was asking what I was doing? Or careful when I cross the road*

because she could see that I had left the house. Um… So, it was quite funny and cute." AC5

Two adult children felt a need to report the false signals if the phone was not with them when they arrived/left their home. They felt they needed to let their parents know if they went out and left the phone at home, generating a false impression that they were at home the whole time. For example, a daughter mentioned,

"I was aware sometimes that I would be creating false positives by a sort of popping to the shop or leaving my phone somewhere…. [] For example, my brother and I went over the road to the pub and umm.. We told her (the parent) that that would have looked like we were at home because the pub is within my home range, so I giggled about it (laughs) it was generally sort of fun." AC1

Some children let their parents know if they were going to be away from home, as they did not want their parent to worry about why the lamp did not turn on. All of these instances created opportunities for conversation and therefore more contact between the pairs. Five out of six pairs said they had more contact during the phase when they used the lamp and felt closer to each other as a result.
The *SmartLamp* became a prompt for conversation not only with their distant child (i.e., the study participants) but also amongst family members that lived with parents or people that visited the parents' house (i.e. those not involved in this study). A mother mentioned,

"A part of me sort of misses that... it became a sort of a light-hearted thing between me and my husband "Oh she is home, oh she is gone out", and it's a quite nice thing" P3

Another mother mentioned,

"I would like to keep it (SmartLamp) working as it is. So it tells me when he (her son) is in... Also, because it is fun... It's positive, and it was also interesting when I had people around, and it switched on, they were all curious about it, so it was a nice thing to talk about" P2

This suggests that these parents felt generally positive about the *SmartLamp* systems and it could be beneficial not only to their relationship with their adult children but also an interesting topic of social conversations.

Subtheme 2.4: Availability of contact
As mentioned in the subtheme 1.1, parents mentioned wanting to have more contact however some of them may hesitate to do so in case their son/daughter may be busy.

Also, adult children felt a sense of guilt of not making enough contact with their parents. *SmartLamp* partially helped to address the issue as it is activated automatically. Although it did not replace communication, it created more connection with their adult children without them having to remember to take any action manually. A mother said that she particularly liked the idea of her son not having to do anything to turn on the lamp as she did not want to interrupt his (perceived) busy schedule.

> *"I knew he was very busy with his studies, so I didn't want to bother him about it, I was happy if it [SmartLamp] turned on." P2*

Four out of six parents mentioned feeling uncomfortable about initiating contact with their son/daughter because they feel that they may be busy with work and they do not want to disturb them. The *SmartLamp* system addressed this problem, as parents suggested that this type of system would be beneficial if they were reliably able to report the availability of their adult child so that they could be contacted via other communication media,

> *"Lamp system would be great if you phoned or Skype because you were not disturbing that person at work. Would probably be very good for an elderly friend/relative, so you knew they were back home safe. Perhaps it could be triggered when they went to bed and got up in the morning which could alert you to a problem if it didn't trigger." P4*

This showed the potential of awareness technology to work as an icon of availability so that parents would know that they are free and might be available for communication.

Theme 3: Costs of *SmartLamp*

Participants mentioned some concerns while using the lamp which can be conceptualised as costs of using the system. This theme encapsulates the costs reported by parents when they started using *SmartLamp.*

Subtheme 3.1: Out of sight out of mind

All parents reported that the experiences evoked through *SmartLamp* were similar to when their son/daughter was living together with them. Five out of six parents mentioned the phrase 'Out of sight, out of mind' in reference to the fact that because their son/daughter was not any more living with them, they did not have some information that would otherwise worry them. For example, if the lamp was not activated in the evening, parents started worrying why their son/daughter was not yet home. A mother who particularly described herself as of a 'worrier' nature mentioned,

> *"When it is getting late, and the lamp has not triggered on, you can begin to worry as why she isn't in and feel tempted to message*

her to make sure she is okay or whether the lamp has failed. In the worst case, I might be tempted to stay up late till lamp did come on! In the 'lamp off' period, you think of that person less without the lamp reminder and because there isn't any way to know of their whereabouts you don't worry." P4

Subtheme 3.2: Threat to privacy

All parents were aware that their adult children consented to their arrival/departure of a location of their choice being known to their parents during the study. None of them mentioned having any issues with their parents knowing this one activity. However, some parents of 30+ years' children mentioned feeling uncomfortable knowing about the arrival/departure of their adult children,

"...I felt like I was intruding on her life. At first, I left a little awkward like it was information about her comings and goings that I wouldn't normally expect and felt a little bit like it was an intrusion" P1

It was interesting that none of the adult children showed sharing of activity information (arrival/departure from a location) as a threat to their personal space or privacy. A daughter mentioned, although the lamp was 'stalker' like, she did not have any problem with sharing this activity information with her parents,

"It's quite funny in that it's a bit stalker-like…but… I don't mind it, I mean it doesn't bother me" AC4

Unlike the parents of 30+ years' adults, the parents of younger adults did not express any concern about intruding on their son/daughter. Because these younger adults had moved away more recently, their parents still missed living with them and saw them on a regular basis. Parents of the younger adults mentioned they would use such systems if it were a commercial product. A mother mentioned,

"I like the idea; I think I would buy it yes. Maybe not always (use it) but I would have it as a fun thing for a while." P2

3.6 Discussion and findings

This study was intended to explore how an awareness system using connected artefacts placed in the parents' surroundings may support distant parent- adult children relationship. This was to understand how well these technologies could support this relationship as well as what the desires and needs of this relationship were. We designed a system called the *SmartLamp* that used smart switches and mobile phones to create awareness of the distant son/daughter in their parents' life. This was an asymmetric synchronous system that was placed in the home of parents

and used light as a medium to create awareness of the arrival/departure of a distant son/daughter.

We used social presence and closeness as quantitative variables to evaluate the system. We also gathered qualitative data from free-form questions in diaries and interviews to understand the communication between parent and adult children and their experiences with using *SmartLamp* as an ambient awareness device. The findings from qualitative and quantitative data indicated that awareness systems such as *SmartLamp* could be of value to parent- adult children relationship by creating more connection between them.

In RQ1 we hypothesised that the *SmartLamp* would foster positive feelings of closeness between the dyads of parent-adult children. This hypothesis was confirmed. The closeness reported by parents on the days *Smartlamp* was used, was significantly higher than the days they had no contact, suggesting that awareness system have a good potential to create closeness between parents and their adult children. Also, the closeness reported by parents during the week they started using the lamp was significantly higher than the week before they used the lamp. The adult children who did not have the lamp had no significant difference in the feelings of closeness over the study duration. These findings also strengthen our hypothesis that the *SmartLamp* could increase the feelings of closeness towards the other. This could be because of two reasons, firstly the awareness of the son/daughter's routine created via *SmartLamp* and secondly an increased frequency of contact between the two. Awareness has been suggested as a strategy to foster the feeling of *relatedness* (Dey & de Guzman, 2006; Hassenzahl et al., 2012). Therefore, creating awareness of activities or routine and/or location could support the closeness between parents and their adult children. The other reason for the increase in closeness could be that the lamp created more contact between the pairs, they spoke more often with each other for a number of reasons, therefore, increasing the frequency of contact. The literature has shown a positive association between frequency of contact and closeness in parent-adult children relationships (Dunleavy, Wanzer, Krezmien, & Ruppel, 2011; Golish, 2000; Lawton et al., 1994) suggesting that creating opportunities to create more contact between the dyads could foster the feelings of emotional closeness.

The observation of the communication between the dyads and the needs of parents and adult children during the study showed that both dyads desired a sense of connectedness with one another. However, the parents need for connectedness seemed to be more than their son/daughter. Although sons and daughters did desire connectedness, they may have found it difficult to maintain for a number of reasons and hence some may have felt a sense of guilt for not contacting their parents enough. Some parents hesitated to contact their adult children, thinking that they might be busy and may disturb them. It was interesting to see that the *SmartLamp* was able to satisfy their emotional need of maintaining a connection and feeling reassurance of their wellbeing yet maintaining some distance. Also, they were more

aware of the availability of their son/daughter so could initiate communication when their son/daughter was at home. This could be, however, problematic in cases when the sons and daughters worked from home or were busy doing something else, but parents may think that their son/daughter is free to talk. A solution could be a clearer way of conveying availability, perhaps having a different colour of light representing the status as busy, away, and available.

The *SmartLamp* was useful for busy adult children in a way that they could maintain a sense of connection without having to take any action. This is not to suggest that the awareness systems such as *SmartLamp* could replace communication. We believe that the use of such devices could be seen as a complimentary way to stay connected in addition to the usual communication. Our finding is supported by the literature of awareness technology where such technologies have been an additional way of maintaining a sense of connection with families, romantic partners or work colleagues (Chen et al., 2006; Dey & de Guzman, 2006; Dourish & Bellotti, 1992)

Qualitative analysis showed that there were some benefits of *SmartLamp,* such as more connectedness, awareness and closeness and there were some costs such as a threat to privacy and feeling of worry. Literature shows that distant parent and adult children do worry about each other and their worries reflect individual characteristic and relationship characteristic (Hay et al., 2007). These findings are in line with the findings reported by Bales, Li, and Griwsold (2011) who reported that awareness of location provided peace of mind to distance romantic couples. However, this finding was only applicable to the particular couple who took part in their study as one of the partners cycled to work which made other partners worry about them. In terms of parent-adult child relationship, the findings of a preliminary study reported by Tollmar and Persson (2002) also suggest that awareness gave participants a sense of 'things being okay' in the other household. This is something that a very few of the previous studies of awareness have shown and could be something unique to the relationship between parents and adult children.

Another cost of the *SmartLamp* was a threat to privacy concern. In our study, a few parents, especially parents of older adults felt more uncomfortable about knowing the whereabouts of their adult son/daughter than their son/daughter felt about an invasion of privacy. None of the adult children suggested that they had a problem with their parents knowing about them coming or leaving home which suggested that their parent's concern of intrusiveness was unfounded. This could be because, in this study, the awareness of a single location was shared, and adult children had control over the sharing of this data which could have made them feel more comfortable with using *SmartLamp.* This is not to say that adult children would not have an issue if their activity information at all times is shared with their parents or with any other close person. Previous studies on novel communication technologies have shown that sharing of activity information can be seen as an intrusion of privacy for some of the users (Hassenzahl et al., 2012). However, it has not been studied previously in

the context of a parent-adult child relationship. To the best of our knowledge, this was the first study that reported that parents of older adults feel they might be intruding rather than adult children feeling the threat to their privacy. It was also interesting to note that the parents of younger adults did not worry about intruding in the privacy of their adult children.

One of the options that are suggested to reduce the 'threat to privacy' concern is an abstract representation of the information and limiting the information to close family members (Kuwabara et al., 2002). In the design of *SmartLamp*, the information was presented in an abstract form using lights. Also, we limited the amount of information shared to a single location, therefore, minimizing the privacy issue.

From the analysis of qualitative and quantitative findings, we believe that the affective benefits of our system outweighed the costs. We found that the *SmartLamp*, when used, fostered a positive feeling of gentle connection between parent and adult children relationship.

3.6.1 Note on Social presence:

We thought of using Social presence to evaluate *Smartlamp* as it is defined as a quality of medium (Short et al., 1976) and has been used by number of other researchers to evaluate communication technologies (Davis et al., 2015; Gooch & Watts, 2010, 2014; Huijnen et al., 2004). The aim was to explore a relationship between the social presence (which is defined as a variable of communication technology) with closeness (which is an important relational variable). If correlation was found, we could argue that designing technologies that creates high social presence could support closeness in distant relationships. From RQ 3, we did find a positive correlation between social presence and closeness. These findings are supported by the literature, for example, Gooch and Watts (2014) also found a positive correlation between closeness and social presence. However, results from RQ 2 show *SmartLamp* has a lower rating of SP compared to some other ICTs such as telephones although these differences were not significant. This does not diminish the value of *SmartLamp* to support parent-adult child relationships as from the result of RQ1 and RQ 4 we can see that *SmartLamp* did foster feelings of closeness and connectedness between parent-adult children. Also, most participants reported having an overall positive experience with the lamp. Upon closer inspection, we found this could be because of the issues with measuring social presence.

Each communication media had a wide range of social presence ratings and ratings also varied a lot from participant to participant. Instant messaging had the lowest mean SP score reported by all participant although it was the most commonly used technology between parent and adult children. It was interesting that the two parent participants who reported SP score for lamp reported highest SP score for instant

messaging. Also, they reported similar SP rating of *SmartLamp* and face to face meetings suggesting that the social presence is not influenced by the 'richness' of the media (media that provides richer cues). The SP ratings seem to be influenced by the context of technology use and topic of conversation. The interactions that were reported as 'happy' or positive had higher SP score and the ones reported as 'frustrating', 'angry' had lower SP score. This suggested that SP cannot be thought as a purely property of medium as suggested by previous literature and is affected by other factors such as the context of use. For example, a parent participant gave same SP score to telephone and instant messaging (IM) app although telephone allows 'richer' information such as audio to be communicated. Also, a daughter reported higher SP score for letter/post than face to face contact. Looking at the information from the diary associated with this particular entry mentioned that the post which was a package, included chocolates and a congratulations card which made her feel happy. These results suggest that social presence is not purely a property of a medium.

It was interesting to find that only two out of six of parent participants provided a social presence score of the *SmartLamp* although all six used the lamp. It is not clear why four parents did not rate the system. One reason could be because our participants did not view awareness technologies as a communication technology; hence they did not provide Social presence score for *SmartLamp.* The other reason could be because the instructions to fill in the diary went unnoticed although all the participants were also verbally instructed prior to starting the study. Casual conversations with our participants revealed that they found the semantic differentials measure of social presence confusing and unclear. As mentioned before there is no reliable measure of the social presence and there is still a lack of a well-validated measure for measuring social presence.

3.6.2 Connectedness and Social Presence:

The results of this study suggest that while using the *SmartLamp*, parents felt more connected to their son/daughter. They were more aware of their routine and could visualise them at their home or crossing the road when the lamp switched on or off. This feeling of being connected or 'being in touch' is defined as connectedness (IJsselsteijn et al., 2003). In this study, connectedness was evoked by the awareness of the other but was irrespective of their presence. The qualitative findings from this study suggested that parents and their adult children desired more connectedness than they actually had. Therefore, we argued that social presence, although an important concept may not be appropriate to evaluate awareness technologies designed for interpersonal relationships and that connectedness is more relevant.

The concept of connectedness is related to the concept of social presence, but it is not equivalent. Social presence is the perception of 'being together' with the other person when communicating via ICT, whereas connectedness refers to 'being in

touch'. IM and text messaging demonstrate the difference between the social presence and connectedness. The awareness that others are online in IM conveys connectedness, even when there is no message exchange, similarly, the exchange of 'goodnight' text messages creates connectedness (Rettie, 2003). In awareness systems, there may be virtually no social presence, i.e. little salience of the other person, and no access to their intelligence, intentions or sensory impressions, however, at the same time there may be a feeling of psychological involvement and experience of connectedness. IJsselsteijn et al. (2003, p. 927) propose that the concepts of 'social presence' and 'connectedness' are complementary, arguing that in awareness systems the level of Social Presence will be very low, but the "sense of connectedness, the feeling of being in touch, can be strong" which was also shown by the results of our study. Hence, for our future studies, we would be using connectedness instead of social presence as one of the variables to evaluate our systems.

3.7 Limitations and future work

Our exploratory study indicated that devices based on awareness of activities could be successful in supporting distant parent-adult child relationships. We appropriated commercially available IoT products such as WeMo switch. With IoT, interoperability is one of the big issues. Reliability was another issue that made the system not dependable in a few instances. The system was asymmetrical as we assumed that parents need for their adult children awareness may be higher. Although our data support this assumption, we do not know the implications how such system could be used by adult children and what experiences they may have from awareness of their distant parents. We believe there is potential for awareness system to be useful for parents as well as adult children. Therefore, future studies could explore the effectiveness of such systems when they are placed at both adult children as well as their parents' home.

We built on these findings to design a symmetrical system that can be used by both parents and their adult children. The study presented in current chapter used awareness as a design strategy for fostering closeness, which was triggered automatically. For our future study, we wanted to explore the potential for connected devices that are expressive in nature. Instead of implicitly creating awareness, we wanted to explore how explicitly triggered subtle messages of 'thinking of you' could support this relationship. This study employed habituated objects which were situated in the surrounding of the users. Therefore, in next study, we wanted to explore the awareness created by expressively sent signals using wearable technology. This is explored in Chapter 5.

A key finding of this study was the limitation that social presence was not an appropriate measure to quantitatively assess the effectiveness of *SmartLamp.* We argued that connectedness might be a more suitable phenomenological concept to

evaluate these types of communication technologies. We, therefore, focused on connectedness for our future studies.

One of the key findings of this study was that parents and adult children desire more connectedness than they have, and parents need for connectedness was higher than their adult children. A limitation of this study was that we only had 12 participants. Therefore, we could not generalise these results to the wider population. To address this, we explored if this could be generalised to the wider population using two online survey studies which are presented in following chapter (see Chapter 4).

3.8 Conclusion

Our findings conclude that pairs had more contact during the days they used the lamp and parents reported feeling closer to their distant child. There are distinct differences between communication needs of parents and adult children. In terms of social presence, we found that our participants did not view *Smartlamp* as a communication system. Hence only two out of six parents provided the social presence data from the system. We argue that social presence is not a suitable concept to evaluate awareness technologies and connectedness is more relevant.

4 Chapter: A Survey Exploring ICT Use and Levels of Connectedness between Parents and Adult Children

This chapter reports a study which used two online questionnaires to investigate how current communication technologies are used by parents and adult children to maintain their relationships. The study also aimed to determine if parents and adult children desire more connectedness than their actual connectedness. Also, we aimed to determine if there is any association between frequencies of contact, number of technologies used, connectedness, closeness and relationship satisfaction. Additionally, we investigated what parents and adult children miss when living away from each other. The first part of this study collected data from adult children and the second part collected data from parents that had adult children. It was found that variations in technology use were linked to the relationship type (gender), the living locations (distance) and the age of users. Additionally, it was found that the desired connectedness of parent and adult children is significantly higher than their actual connectedness and parents' desired connectedness is significantly higher than adult children's desired connectedness. Also, it was found that the total number of technologies used, connectedness, closeness and relationship satisfaction reported by adult children to both parents were positively correlated. The positive association was also found between these variables reported by mothers to their adult children however no association was found between these variables reported by fathers. Finally, it was found that people mainly miss each other's presence and knowing about each other's wellbeing when living away from each other.

4.1 Introduction

This thesis explores how novel technologies can be designed using off-the-shelf IoT to support closeness and connectedness (i.e. the feeling of being in touch) in parent adult-child relationships. Currently, there is little evidence for whether parents and their adult children desire connectedness and what value connectedness has for this particular relationship. Qualitative findings from the evaluation of the *SmartLamp* study discussed in Chapter 3 directed us towards the desired connectedness of parents and their adult children. The study, however, was carried out with six pairs of participants. Hence we could not generalise these findings. Also, in order to understand how novel communication technologies can be designed, we needed to understand how current information and communication technologies (ICT) are used to maintain this relationship.

Connectedness refers to the phenomenon whereby a person desires a constant sense of connection with another person even when they are physically separated (Rettie, 2003). The use of ICTs can create a feeling of connectedness (Kuwabara et al., 2002). Qualitative research has indicated that connectedness has a positive effect on family relationships (Chen & Katz, 2009), although it is not known if there is an association between connectedness and closeness in the relationship. Parents and

adult children relationships are especially understudied (Schon, 2014). It has been reported how ICTs can affect peer relationships and parents' communication with their young children, however, how ICTs influence parent adult-child relational closeness and connectedness is less clear. Peoples desired connectedness (DC) within this relationship and how it compares with their actual connectedness (AC) has also yet to be considered. As part of a larger research effort investigating the use of technology to support connectedness between parents and adult-children, we sought to better understand how parents and their adult children currently stay in touch with each other.

This study had three aims,

1. To understand how distant parents and adult children manage contact over the distance.
2. To understand what value does connectedness has for this relationship and if distant parent and adult children desire more connectedness than they actually have.
3. To understand what do physically distant parent and adult children miss and what are their needs.

We carried out two questionnaire studies, one that collected data from adult children and another one collected data from parents. These adult children and parents were not related. However, it did give us an understanding of adult children as well as parents' perspectives. In this chapter, we address the adult children survey as the first part of the study and the parents' survey as the second part of the study. The first part asked questions of the adult children about their mother and father. The second part asked questions of the parent about one of their adult children - son or daughter. We quantitatively collected data about their ICT use, desired connectedness, actual connectedness, closeness and relational satisfaction. We also gathered qualitative data from open-ended questions about how they feel about their contact and if their needs were being satisfied with existing technologies. The data we gathered allowed us to characterise parents' and adult children's current communication and sharing patterns, as well as generating an understanding of the value of connectedness for this relationship.

4.2 Background and related work

The widespread use of information and communication technology (ICT) in society impacts how we maintain relationships and connections with others (Kim, Kim, Park, & Rice, 2007). This is important for adult children and their parents, as people travel far from home for various reasons such as work, education, or simply living separately when adult children grow older. However, relatively little research has analysed the use of ICT among adult children and parents (Schon, 2014). Some of the previous literature in this area focuses on ICT use between college students and their parents (Chen & Katz, 2009; Gentzler et al., 2011; Hofer, 2008) and there is

little research that looks at a different range of ages of adult children and their parents. Also, there is little research on connectedness between these relationships.

In this section, we discuss the current state of research in the area of ICT usage to maintain relationships between geographically distant adult children and their parents. The key areas where knowledge is lacking are presented and are used as a foundation from which we generate our research questions for this study.

4.2.1 Type, frequency and number of ICTs used between adult children and their parents

The reason we assessed how current technology is used is to understand why that technology is used over the others. The facets that make these technologies popular could guide us while designing new technology. The type, frequency and number of ICTs used are obviously important factors to consider when approaching the topic of the role of technology in parent adult-child relationships. Current progress in this area will be discussed along with considerations of how the factors of distance, gender and age may be related.

Types of ICT Used

Ramsey et al. (2013) indicate that almost 100% of college students use a mobile phone to communicate with their parents, and that rates of student-parent communication by text and social networking websites are increasing (from 64% and 24% in 2009 to 85% and 45% in 2011, respectively). However, e-mail communication with parents is declining (Ramsey et al., 2013). Their previous research has also revealed that the type of ICT that students use with their parents is related to unique relationship qualities (Gentzler et al., 2011). For instance, early research indicated that students who used social networking websites with their parents were lonelier, more anxiously attached, and had more conflict with their parents but more recent research indicates that using social networking to communicate with parents is no longer associated with poor outcomes (Gentzler et al., 2011). In addition, adult-children' frequent telephone communication with parents is consistently associated with positive relationship qualities (Chen & Katz, 2009; Gentzler et al., 2011; Ramsey et al., 2013; Wei & Lo, 2006). Overall, communication between parents and adult children (particularly using certain ICT channels) may enable students to maintain close, positive relationships with parents (Ramsey et al., 2013). Research has shown that the ICT use with parents could benefit students transition into college (Mattanah et al., 2004; Wintre & Yaffe, 2000). An opposing concern noted by Hofer and Moore (2011) is that ICT could result in students' overreliance on parents. Although these studies focus on university student-parent interaction, they provide evidence that contact using ICT may influence the well-being and development of adult children.

The frequency of ICT use

Research on the impact of the internet and mobile communication on social relationships have found that increased online social communities often complement offline social interaction (Crang, Crosbie, & Graham, 2007). It seems that this may especially be the case for parents and adult children who live long distances from each other, as they may rely on ICT more heavily to maintain their relationship if frequent face-to-face contact is not practical or possible. In support of this, research indicates that young adults communicate with their parents quite frequently, averaging 13 times a week when looking across multiple types of ICT (Hofer, 2008). Research shows that frequency of ICT use for communication between parents and adult children is increasing, e.g., in an American study reported in 1989, 32% of adult children had daily communication with their parents (usually mothers) which rose to 42% in 2005 (Taylor et al., 2006). The authors report that as the cost of technology is decreasing, the frequency of contact using ICT is increasing. Other studies using a UK sample also have found that frequency of contact between parents and adult children is increasing as older parents are increasingly using mobile phones as well as landlines to stay connected with their sons and daughters (Hardill & Olphert, 2012). It has been reported that adult children who more frequently use ICT with their parent report higher-quality relationships with them, in part because they can feel connected and present during their communications (Gooch & Watts, 2014; Ramsey et al., 2013). Most of the previous studies were carried out on American samples, and there are very few recent studies from UK or Europe on parents and adult-children that report on the frequency of using ICT technologies to stay connected with each other e.g., (Rubin, 2015).

Number of ICT used

In this thesis, we propose designing new technologies to support connectedness that could be used in addition to the technologies parent and adult children already use to maintain relationships. This additional media would increase the total number of technologies used by adult-children and their parents to maintain contact. Therefore, it was important to examine the number of technologies used to connect with mother and father. It is important to note that the total number of technologies is also referred to as the total number of media or communication repertoire size (CRS) (Haythornthwaite, 2005a; Schon, 2014). Any mentions of these terms in this thesis refers to the total number of ICT technologies used for communication.

According to media multiplexity theory, the total number of media used is positively associated with tie strength of interpersonal relationships (Haythornthwaite, 2005b). Granovetter (1973) introduces strong ties and weak ties as fundamental types of social connections that carry divergent costs and rewards. Although relationships with strong ties such as close friends and immediate family members provide individuals with a sense of belonging, emotional stability and access to physical types of help, they require large amounts of time and energy to maintain the bond. Weak ties in contrast, such as, co-workers and some extended family relationships,

do not offer the same sense of belonging and intimacy of strong ties. On the other hand, they take less time to maintain and can be beneficial by providing access to a larger range of resources and information than is available in a strong tie relationship. In light of her study into media use, Haythornthwaite (2005b) extended Granovetter (1973) view of social networks by proposing that the number of media used in a relationship is a defining characteristic of tie strength. She proposed that strong ties tend to employ multiple media to uphold their level of interdependence, unlike weak ties which may communicate via only one or two media. Media multiplexity is the link between tie strength and diversity of media use. This association is mutually causal across time, tie strength causes greater media use, and the use of multiple media also reinforces the relational tie (Taylor & Ledbetter, 2017). Additionally according to MMT, the total number of technologies used in a relationship, is positively associated with relational interdependence and closeness (Haythornthwaite, 2005b). This is corroborated by Schon (2014) who found a positive association between young adult's relationship satisfaction and the number of media used with parents. However, Schon (2014) study focuses on young adults from an American university making it difficult to generalise the results. This focus also precludes the consideration of parents in the relationship.

To the best of our knowledge there is no study that assess the number of technologies used to communicate between parents and adult children of different ages. Also, there is no study that explores the association between numbers of media types used in relation to connectedness. Therefore, in this study we explored the number of technologies used by parents and adult children and if there are differences between mothers, fathers and adult children. Also, we assessed if there was any association between the total number of technologies used and connectedness, closeness and relational satisfaction.

Most research on parents and adult-children's ICT use is carried out with adult-children and very few report findings from a parent's perspective. Most studies that investigate adult-children's technology use with parents, focus on college students or young adults (Ramsey et al., 2013; Schon, 2014). A few studies that do ask parents about their technology use with their adult-children report only telephone and text messages and do not report/account for various other ICTs that might be used by parents (Fingerman et al., 2016). To the best of our knowledge, there is no study that reports ICT use from both an adult-children and parents' perspective.

Effect of different factors

The following sections outline how distance, gender, and age influence adult-children's and parents' ICT use and relationship qualities.

Distance

One repeated observation in research on frequency of contact for social purposes is that distance is important (Sharmeen, Arentze, & Timmermans, 2014). Studies have shown that geographical distance between family members is strongly associated with the frequency of face-to-face contact (Bengtson & Roberts, 1991; Grundy & Shelton, 2001; Lawton et al., 1994; Lee, Netzer, & Coward, 1994) and the provision of support (Leach & Braithwaite, 1996; Rossi, 1990).

The further parents and children live away from each other the less they see one another (Bucx, Van Wel, Knijn, & Hagendoorn, 2008; Fors & Lennartsson, 2008; Grundy & Shelton, 2001; Mok, Wellman, & Carrasco, 2010). However, few studies study the effect of distance on frequency of contact using ICTs between parent and adult-children living separately. Rossi (1990) and Treas and Gubernskaya (2012) found "distance decay" for the frequency of telecommunication based contact for general social contacts. Similarly, studies on parents-adult children also report a negative association between distance and frequency of contact (Kafková, 2017; Rubin, 2015). However, these studies measure road distance, which is likely not the most important factor when considering distance in a parent adult-child relationship. We found only one study on an American sample that categorised the dyads based on living together, living in the same town and living in a different town (Taylor et al., 2006), although again dyads living in separate countries were not considered. They reported a significant increase in contact frequency over the years between dyads that lived in a different town (same country) from 8% in 1989 to 22% in 2005. They did not report if there is a statistically significant difference in contact frequency between dyads living together, living in the same city and living in a different city in same country. However, looking at their descriptive data there is a decrease in contact frequency with increase in distance. For example, 98% dyads that live together have daily contact, followed by 56% that live in same town and 22% living in different town in same country. As mentioned, there are no studies that include dyads living in a different country. Also, they do not quantitatively measure frequency of contact and they do not compare with people that live separately in same country.

Frei and Axhausen (2009) found that the association of distance with frequency of contact depends on the mode of telecommunicating. No effect of distance was found for email communication, while SMS and telephone contact decreased with distance. Nowadays, monetary costs of telecommunicating are likely to be insensitive to distance so there is a need to revisit these results. However, distance is not only physical but can be emotional. It is probable that physical distance is also associated with emotional distance between parents and their children. Looser emotional ties between adult-children and their parents would then be associated with larger distance separating them (Steinbach & Kopp, 2007). Rubin (2015) also found that contact between parents and adult-children was negatively associated with distance. However, most of the studies mentioned here are carried out with adult-children living in the same country. Also, the reference to contact in some studies includes

contact including telecommunication and, in some studies, only considers frequency of face to face contact. Therefore, there is a need for a study which considers parents as well as adult-children, recognises that distance measured in road miles might not be a sufficient measurement, considers dyads living in separate countries and has a focus on ICT use rather than face to face contact.

The increased mobility of ICT allows children and parents to accomplish relational goals (e.g., keeping in contact) as the increased mobility allows people to interact anywhere, and thus, reduces the time necessary for relational maintenance to take place (Castells, 2011). The mobility of today's ICT has clear significance for those trying to connect across large distances, including adult-children and their parents. Recent research on college students and parents suggests that students who live very far from their parents choose different forms of ICT (e.g., Skype, email) to maintain the relationship (Yang et al., 2013). Thus, we expect that distance will similarly influence the amount and type of ICT use that adult-children use with their parents. In the context of this study, we measure the proximity of the dyads based on their living situations rather than the physical distance between them. There were four categories, dyads that live together, live in the same city but different houses, live in different cities but the same country or live in different countries.

Gender

When studying intergenerational relationships, how gender may mediate child-parent relationships is important to consider (Booth & Amato, 1994; Rossi & Rossi, 1990). Previous studies have found several differences associated with gender. Firstly, females are more involved in maintaining intergenerational relationships than males (Spitze & Logan, 1990a), and mothers often mediate the relationship between daughters and fathers (Aquilino, 2005; Rossi, 1990). As there is a greater investment by females in family relationships, it follows that both sons and daughters report more positive relationships with their mothers than with their fathers (Thornton, Orbuch, & Axinn, 1995). Secondly, same-sex dyads tend to differ from cross-sex dyads. Children often relate with the parent of the same sex more strongly (Aquilino, 1994). It is logical then that daughter-mother relationships are found to be closer than the other dyad types. There is good reason, therefore, to study connectedness and closeness individually for each type of gender configuration.

In terms of use of communication technologies, many studies examine how socially constructed gender roles impact the use of ICT (Rogerson, 2008). Specifically, rates of ICT use differ by gender, as women tend to use online communication more than men (Hartsell, 2008), and tend to use the phone to contact their family more often as well (Chen & Katz, 2009; Wei & Lo, 2006). Thus, adult-children's ICT use is related to gender roles in society. Moreover, research suggests that it is important to consider the gender of the parent in addition to that of the student. For example, adolescents' social networking site (SNS) use with their family is positively related

to their reported warmth and support with their fathers but not their mothers (Coyne, Padilla-Walker, Day, Harper, & Stockdale, 2013). In addition, college students are more likely to report wanting more communication with fathers than they currently have compared to their desired contact with mothers (Hofer, 2008). Therefore, it is necessary to take both adult-children and parent's gender into account when examining the influences of gender on ICT use. However, in this study, we focus on the effect the gender of the parent has on the parent adult-child relationship. There are two reasons for this. Firstly, previous literature has demonstrated the effect of the gender of the parent has a greater impact than the gender of the adult-child, therefore it is reasonable to have this focus (Fingerman et al., 2012; Fingerman et al., 2016; Schon, 2014). By focusing on the gender of parents, our results could be compared with the previous literature. The second reason is due to the need for simplicity in the study to produce the clearest results.

Age

There have been multiple studies that have found a negative association between technology use and age (Horrigan, 2007; Selwyn et al., 2003; Zickuhr, 2011). We argue that age may influence how ICTs are used in parent-adult-children relationships. Schon (2014) found parents' use of ICT has a positive association with relational satisfaction among emerging adults. They also found that ICT plays a major role in maintaining healthy relationships with their adult-children. However, their findings are limited to younger adults and they do not include the parent's perspective in their study. We extend their findings to examine the differences in ICT use based on an adult child's age.

In this study, we categorise the data based on the age of the adult-child in the relationship. The names used for the categories are young adults (18-24), adulthood (25-34), middle age (35- 54) and later adulthood (55+). Descriptions of the age groups are based on those presented in "Development through Life" by Newman and Newman (2017).

We have discussed the differences in technology use depending on distance (where people live), gender (the relationship type) and age. We found that previous studies focus on a particular country and do not employ people living in different countries. Also, most previous studies focus on university student or young adults. The other age groups have been understudied and there is a need for a deeper understanding of what technologies are being employed in relation to the age of the user. Additionally, most previous studies only employ adult child or parents, therefore exploring issue from just one perspective. In this study we include people living separately including in different countries, we also include all people above 18 years of age to explore differences depending on age. Additionally, we collect data from two survey studies: adult children and parents. Although they were not related, this gave us an understanding of the issue from both perspectives.

Research in this area is changing fast and quickly going out of date with various new technologies being adopted and more people having access to the internet and technology (Ramsey et al., 2013; Taylor et al., 2006). We acknowledge the changing nature of technology and this survey study captures the ICT use at a particular point in time.

4.2.2 Connectedness in parent and adult-children relationship:

Connectedness refers to the concept where users who are physically separated, maintain a sense of connection using information and communication technologies (Licoppe, 2004; Rettie, 2003). It is a feeling of 'being in touch' with other individuals. A sense of connectedness is engendered by the explicit act of contacting someone as well as a high frequency of contact (Kuwabara et al., 2002; Licoppe, 2004). It is a relatively new concept and little research has been done on the feeling of connectedness between parents and adult children.

Tee et al. (2009) present a qualitative study with 16 participants to understand communication practises of parents and grandparent with their extended family members. Although their study does not specifically focus on parents and their adult-children, some of the participants report their technology use with their adult-children. The authors reported that most of their participants expressed a desire for more communication and sharing with their extended family, however find it hard due to a busy schedule and lack of technology use by extended family members. Their study indicates the desired connectedness of the participants towards their distant son/daughter as well as towards their parents. Their study guides us towards the thorough exploration of desired connectedness, however, their findings were based on accounts of only six parent participants hence they could not be generalised to the larger population. They also do not report if there are any differences based on gender (e.g., mother, father). The focus of their study is sharing photos and calendars and they do not measure connectedness, closeness or any other relational variables.

The findings of our *SmartLamp* study also suggested that parents and adult-children desire more connectedness with each other than they usually have however they find it difficult because of busy schedules. Findings of the *SmartLamp* study were also qualitative and involved six pairs of participants therefore could not be generalised to the larger population. None of these studies quantitatively measure connectedness with parent-adult-children dyads that live separately from each other. We built upon these to quantitatively explore the desired connectedness amongst parent and adult-children. We compared the desired connectedness to see how it relates to their actual connectedness. We argue that if the desired connectedness is higher than actual connectedness and if a considerable number of participants wanted more contact, then we can say that there is a need to support connectedness in this relationship.

We also wanted to understand what value connectedness has for the parent adult-child relationship. We did this by exploring the association between closeness and relational satisfaction with connectedness. Relationship closeness and relational satisfaction are two main components used to assess the relationship (Dibble et al., 2012; Gächter, Starmer, & Tufano, 2015; Vaughn & Matyastik Baier, 1999). We argue that if there is positive association between connectedness and closeness as well as connectedness and relational satisfaction then designing novel solutions to support connectedness in this relationship might be beneficial for maintenance of this relationship.

4.2.3 Experiences parents-adult-children miss when living separately

One of the aims of this study was to investigate what things parents and adult-children miss when living separately. This would provide guidance when considering how novel technologies can be designed to enhance relationships where a parent and adult child live separately.

Reassurance: Hay et al. (2007) found parents and adult-children commonly worried about one another. They found that their worry reflected individual characteristics (e.g., neuroticism) and relationship characteristics (e.g., importance of the relationship and ambivalence). There is very little research in human computer interaction that caters for this need (Consolvo et al., 2004; Mynatt et al., 2001). In an effort to provide 'peace of mind', Rowan and Mynatt (2005) designed digital family portraits to support awareness of an extended family members in the lives of old adults (60 years +) that live independently. The findings of their case study suggest, "even though there was no critical reason for the adult child to be concerned about his mother, all involved parties found utility in the presence of the digital family portraits, even those family members who were not directly involved in the field trial itself." (Rowan & Mynatt, 2005, p. 521). Consolvo et al. (2004) also designed a similar photo displaying prototype for senior adults and their caregivers. They found that awareness of an elderly parent reduced stress of the adult-child that cared for their old parent. The findings of these studies are promising; however, their focus was to support aging in place and caregiving for senior adults hence the features of these displays focused around needs of elderly and carers which may not be appropriate for parent adult-children of different age groups. Therefore, to explore how important the need for this relationship is, we included this as an option to a question that asked participant what they missed when living away from each other.

Support: Psychology literature for parent adult-children has heavily focussed on different types of support exchanges within this relationship (Fingerman, Miller, Birditt, & Zarit, 2009; Schoeni & Ross, 2005). Social support includes financial aid, practical support, advice, information, guidance, emotional support, and companionship (Antonucci, 2001; Vaux, 1988; Wills & Shinar, 2000). Parents may offer advice about pension plans when a child gets a new job, or emotional support

during a relationship breakup. When their mothers simply listened to them talk about their day, young adults reported feeling supported (Fingerman, 2000). This type of support has also been shown to have implications for well-being (Cohen, 2004; House, Landis, & Umberson, 1988; Wethington & Kessler, 1986). Additionally, individuals can provide nontangible aid, such as emotional support, more often than practical or financial support, and it's giving is not limited by geographical distance, or few material resources (Fingerman et al., 2009). Most of these studies however are carried out with parents or on adult-children in isolation and studies on dyads are rare. Therefore, we include support as another option in the survey to understand its importance for this relationship.

Humour: Literature in psychology on parent-adult-children also suggests that humour, sharing jokes and laughter is one of the important yet understudied experiences in parent adult-child relationship (Fingerman et al., 2016). Thus, to understand how prevalent this need is for the relationship, we included this option when asking about the things parent-adult-children miss when living away.

Presence, doing things together, touch: In terms of supporting long distance close interpersonal relationships, researchers in human computer interaction have proposed many technologies to support presence, from doing activities together at a distance to supporting touch over distance (Hassenzahl et al., 2012). These designs have been proposed on the assumption that these experiences are missed by loved ones living at a distance. However, most of these studies do not necessarily explore how important these experiences are to these relationships. Also, most of these studies focus on friends, romantic partners or extended families in general and there are a very few studies that focus on parent adult-child relationships (Keller et al., 2004; Rowan & Mynatt, 2005). The ones that do include this relationship, focus on the design of the artefact and do not explore how important these needs are for parents and adult-children. Neither do they thoroughly evaluate the proposed artefact to understand how well they meet these needs. To understand what experiences parents and adult-children miss the most, we included options of missing presence, miss doing activities together, and miss hugs in the survey.

Based on the literature in psychology on parent adult-child relationships and also the literature on human computer interaction to support close interpersonal relationships, we devised some options for experiences that we think parents and adult-children may miss when living away from each other. They were: knowing about each other's wellbeing, sharing jokes/banter, providing and receiving support (emotional and practical), doing activities together, and presence. We also gave them an "other" option to suggest if they missed some experiences that were not in the options. We also gave an option to select "nothing much" if there was nothing that they missed while living away from each other.

The study consisted of two separate online survey studies that gathered data from two separate samples, which will be referred to as part one and part two. The first questionnaire (part one), collected data from adult-children about their relationship with their father and mother. The second questionnaire (part two) gathered the data from parents about their relationship with one of their adult-child. Data included measures of their demographics, ICT use, and frequency of contact, desired connectedness, actual connectedness, closeness and relationship satisfaction. We also included open ended questions that asked about how they felt about their contact and to explain further about their technology use, what things they miss when living away from each other and how else they would like to connect to one another.

The data from both surveys is presented together. Data from part 1 is presented from the point of view of adult-children and their perception of variables (e.g., closeness, connectedness etc.) with their father and mother. For part 2, the direction of data is parents' perception with their adult-children (e.g. father and mothers reporting their closeness etc. towards their adult-children).

4.3 Research questions

There were three main research questions in this study:

RQ1: How do distant parent-adult children manage contact over distance?

RQ 1.1: What type of technologies are used?

RQ 1.2: How frequent is the communication between parents and their adult children?

RQ 1.3: How many total numbers of technologies are used by parents and adult children and if there are differences between mothers and fathers?

RQ 1.4: Is there a relationship between the number of medias used and connectedness, closeness and relationship satisfaction?

These research questions attempt to answer the overall thesis research question (RQ1b, RQ1d) presented at the end of the literature review (see Chapter 2 Section 2.10).

RQ2: What value does connectedness have for this particular relationship?

RQ 2.1: Is there a relationship between connectedness and closeness or relationship satisfaction?

RQ 2.2. Do distant parents and adult children desire more connectedness than they actually have?

RQ 2.3: Is there a difference between desired connectedness of adult children and desired connectedness parents?

This research questions attempts to answer the overall thesis research question (RQ2) presented at the end of the literature review (see Chapter 2 Section 2.10).

RQ 3: What do physically distant parents and adult children miss and what are their needs?

4.4 Method

4.4.1 Ethics

Ethical approval for this study was granted by the University of Bath, Department of Psychology Ethics committee, Ref: 16-181. Included in the Appendix C are the consent and ethics forms that were submitted to the ethics committee.

4.4.2 Participants

Adult-children survey

To collect the data for part one of the study in which adult-children were invited to answer questions about their father and mother, adult children filled in the questionnaire for both of their parents, provided their parents were alive and they had contact at least once a year.

For part one of the study, 1103 adult children responded to the survey. Sixty three percent were female and 36% were male 1% preferred not to say. As we were interested in people's gender to determine if they were a son or daughter, we removed participants that did not disclose their gender. We also removed the participants that did not complete the survey. Additionally, we removed all the participants that lived with their parents. After cleaning the data there were 644 participants. Out of the cleaned data 50% were from the UK, 50% from different parts of the world. 77% lived in the UK and 23% lived in the other parts of the world. 45% were students, 50% were working professionals and 5% did not work, or looked after family.

98% of respondents used smart phones and 2% used old generation phones. 78% of fathers and 77% of mothers used a smartphone, 19% of fathers and 18% of mothers used older generation mobile phone, while 3% of fathers and 5% of mothers did not use mobile phones. 7% and 11% of participants lived in the same city but different houses from fathers and mothers respectively, 45% and 45% lived in different cities but the same country from fathers and mother respectively, while 47% and 45% lived in different countries from fathers and mothers respectively.

Out of 644 participants that completed the questionnaire, 559 completed questions for fathers, 581 completed questions for mothers and 531 completed questions for both. 35% participants were young adults (18-24 years old), 40% were in adulthood (25-34 years old), 22% were middle-aged (35 to 54 years old) and 3% were later adulthood (50+ years older).

Parents survey

For part 2 of the study, we invited parents that had children over 18 years old to take part in the online survey. They had the option to fill it either for their daughter or son as not all parents would have a daughter and a son.

There were 282 respondents to the survey, of which 71% were female, 28% were male and 1% preferred not to say. Similar to adult children survey, we removed the participants that did not complete the survey and participants that filled in the questionnaire for their co-living adult-child. After cleaning the data there were 174 that completed the survey. 5% of participants were between 35-44 years old, 43% were 45-54 years old, 44% were between 55-64 years old, 6% were 65-74 years old and 2% were between 75-84 years old. Out of all participants, 95% lived in the UK and 5% were from different parts of the world. 75% were working professionals, 8% were stay at home parent and 15% were retired. 95% used Smart phones, 4% used an older generation phone and 1% did not use mobile phone. 6% of fathers and 11% of mothers live in the same city but different houses, 67% of fathers and 74% of mothers lived in different cities but in the same country, 27% of fathers and 14% of mothers lived in different countries than their adult-child.

After cleaning data, out of the 174 participants that completed the questionnaire, 50% completed questions for sons and 50% completed questions for daughters. 58% were parents of young-adults (18-24 years old), 32% were parents of children in adulthood (25-34 years age), and 10% were parents of middle-aged children (35-54 years age).

4.4.3 Procedure

The pilot study was conducted entirely online and participants were recruited through advertising on social media platforms such as Facebook and Twitter. Participants could access the link on computer, tablet or mobile phone. Once they clicked on the survey link, they were taken to the information sheet. They were told that the survey is aimed to assess how technologies are used by parents and their adult children to maintain their relationship over the distance. The detailed information is included in the information sheet along with the questionnaires (see Appendix C).

Participants were asked to confirm that they consented to taking part in the study before being directed to some general demographic questions. Following this they were then presented with questions about their respective father/mother/son/daughter that asked about their age, which country they lived, the technologies used with them and frequency of contact. They were then asked questions about their desired connectedness, actual connectedness, closeness, relationship satisfaction and things that they miss the most when living away from each other. They were then presented with optional open-ended questions that asked to elaborate on how they maintain their relationship, how did they use technologies and how else would they like to connect to one another.

The study was expected to take approximately 12 minutes to complete for adult children and 7 minutes to complete for parents. After they completed the survey,

they were given the option to input their email address to be entered into a prize draw. They were then debriefed and thanked for their participation. Two participants that won the prize draw were remunerated £50.

4.4.4 Measures

The following variables were measured. All the measures are included in the Appendix C (see Section 10.5).

Demographics of father/mother/son/daughter

Some demographic questions on father/mother/son/daughter were asked such as age, country of residence, distance (whether they lived together, live in the same city but different houses, lived in different cities but same country or lived in different countries).

Communication Repertoire

Communication repertoire size (CRS) refers to the total number of technologies participants used to communicate with one another (Haythornthwaite, 2005b). Participants were asked to indicate which of the 13 technologies (with the option to include two non-listed others) they use to communicate with their father/mother/son/daughter. Sample items include, ‘‘calling via Mobile Phone” and ‘‘Text Messaging.’’ CRS was calculated by summing each technology that was indicated as used.

Communication Frequency

Participants were asked, ‘‘How often do you communicate with your father/mother/son/daughter?’’ Participants answered using a 7-point scale, with 1 = once a year and 7 = almost daily. Although this is not a standardised measure, it is commonly used to measure frequency of communication. For e.g., see (Schon, 2014; Taylor et al., 2006).

Actual Connectedness

There are a very few standardised measures to quantitatively measure connectedness. The social connectedness scale developed by Lee and Robbins (1995) is one of the popular measures used to measure social connectedness, however the concept of social connectedness refers to connectedness to one’s social world in total, and the more existential feeling of connectedness to the world at large. The connectedness referred in this thesis is interpersonal connectedness and is different to social connectedness.

One of the ways connectedness is measured in previous research was by asking participants to rank connectedness using a Likert scale (Dey & de Guzman, 2006; Grinberg, Kalyanaraman, Adamic, & Naaman, 2017; Rowan & Mynatt, 2005). However, Rowan and Mynatt (2005) saw a ceiling effect with their questionnaire, therefore we decided not to use this questionnaire.

The connectedness questionnaire used in this thesis was found in the work carried out by Schon (2013). She mentioned that the questionnaire was developed from Rettie (2003) and Licoppe (2004) but no other information was found as to how it was developed. However, the questionnaire consists of 8 items which seem to include appropriate questions related to the properties of connectedness based on the definition given by various researchers discussed in Chapter 2 (see Section 2.4) (Katz & Aakhus, 2002; Kuwabara et al., 2002; Licoppe, 2004; Rettie, 2003). Sample items include "My father calls and/or message throughout the day mainly just to exchange pleasantries (hello's, goodbyes)." and "My father calls and/or message throughout the day just to maintain contact." The scale consists of 8 items that are rated on a 7-point Likert scale: 1= "Strongly disagree" to 7= "Strongly agree". Responses of 8-items were summed and averaged to create an index on actual connectedness. The scale had excellent reliability, $\alpha = 0.92$ for fathers, $\alpha = 0.93$ for mothers and $\alpha = 0.95$ for adult-children.

Desired connectedness (DC):

The Desired connectedness Scale was developed by Schon (2013) based on the definition of connectedness given by Rettie (2003) and Licoppe (2004). The scale consists of 8 items that are rated on a 7-point Likert scale: 1= "Strongly disagree" to 7= "Strongly agree". Sample items include "I like when my father calls and/or message throughout the day mainly just to exchange pleasantries (hello's, goodbyes)." and "I like when my father calls and/or message throughout the day just to maintain contact." Responses of 8-items were summed and averaged to create an index of desired connectedness. We computed a Cronbach's alpha for assessing scale reliability. The scale had excellent reliability, $\alpha = 0.96$ for fathers, $\alpha = 0.95$ for mothers and $\alpha = 0.84$ for adult-children.

Closeness (URCS)

The Unidimensional Relationship Closeness Scale (URCS) developed by Dibble et al. (2012) was used to assess relationship closeness. It is a 12-item self-report scale measuring the closeness of social and personal relationships. The items are rated on a 7-point scale: 1= "Strongly disagree" to 7= "Strongly agree". Sample items include "My relationship with my _____ is close." Mean score was generated from all items to create an index on closeness. It is a standardised scale with high reliability across relationship types ($\alpha = .96$) (Dibble et al., 2012).

Relationship satisfaction

A satisfaction scale created by Beatty and Dobos (1992) was used to assess the relationship satisfaction with each parent as it is a validated scale with excellent reliability. The scale consists of these five semantic differential items rated on a 7-point scale: satisfying- dissatisfying, fulfilling - disappointing, rewarding - punishing, positive -negative, and good - bad. Mean score was generated from all

items to create an index on satisfaction. The scale had excellent reliability with α = 0.96 for adult children and α = 0.97 for both parents.

Qualitative measures:
A question asking about what people miss while living away from their father/mother/son/daughter was included. Participants were asked to indicate which of the following things they missed (with the option to include non-listed other). Sample items include, knowing about each other's wellbeing, sharing jokes/banter, providing and receiving support (emotional and practical), doing activities together, presence and nothing much.

Some open form questions were included in the questionnaire which asked adult children to elaborate on their relationship and communication. The questions asked included:

- Please tell us more about how you and your father/mother/son/daughter maintain your relationship with each other when you are apart?
- Can you tell us a bit more about how you and your father/mother/son/daughter use current technologies (phone, instant messenger, emails etc.) to maintain contact with each other?
- Can you think of any other way that you would like to connect to your father/mother/son/daughter? Can you suggest what it may be?

4.5 Results

4.5.1 Descriptive data

Here we include descriptive statistics for key variables from adult children and parents' surveys. We present the results of each research question separately in the next section; however, we included these tables here to get the feel of the data from both surveys. Table 6 presents the descriptive data from the adult children survey and Table 7 presents data from the parents' survey. Tables 8 and 9 present data comparing adult children to parents' survey for father and mother respectively.

Table 6

Adult children survey: Variable Means, Standard Deviations and Results of Paired Samples t-Tests

	Mean and SD		Paired Samples	Effect Size
	Father	Mother	*t*- Test	Cohen's *d*
Variables	(N=531)	(N=531)		
Contact Frequency	5.04 (1.48)	5.84 (1.24)	-13.22**	.59
Closeness	4.90 (1.30)	5.52 (1.28)	-12.44**	.55
Satisfaction	5.74 (1.41)	6.10 (1.23)	-6.79**	.30
Desired connectedness	5.03 (1.40)	5.36 (1.34)	-7.04**	.31
Actual connectedness	4.00 (1.52)	5.16 (1.37)	-18.53**	.82
Communication repertoire size (CRS)	3.35 (1.75)	4.03 (1.90)	-7.84**	.35

**$p < .01$, *$p < .05$

Table 7

Parent survey: Variable Means and Standard Deviations and Results of Independent Samples t-Tests

	Mean and SD		Independent Samples	Effect size
Variables	Of Father (N=49)	Of Mother (N=125)	*t*- Test	Cohen's *d*
Contact Frequency	5.10 (1.31)	5.94(0.90)	-4.13**	1.01
Closeness	5.21(0.93)	5.86(0.77)	-4.32**	.99
Satisfaction	5.94(1.13)	6.49(0.88)	-3.05**	.72
Desired connectedness	6.04(1.00)	6.36(0.88)	-2.06*	.44
Actual connectedness	3.92(1.02)	5.07(1.26)	-5.66**	1.19
Communication repertoire size (CRS)	4.10(1.50)	4.96(1.94)	-2.79**	.59

**$p < .01$, *$p < .05$

All variables, except CRS are multi-item scales measured with a 7-point Likert scale. If a participant averaged between 1.00 and 2.33 on a particular scale, he or she was classified as "low" on that scale; between 2.34 and 4.66 was classified as "medium" on that scale; and between 4.67 and 7 was classified as "high" on that scale. CRS of 0-1 is low, 1-3 is medium, 3 or more is high.

Table 8

Comparing Adult children and Parent's Survey Variables for Father

Variables	Mean and SD		Independent Samples	Effect size
	Adult children for father	Father for adult children	*t*- Test	Cohen's *d*
Contact Frequency	5.04 (1.48)	5.10 (1.31)	-.39	.11
Closeness	4.90 (1.30)	5.21(0.93)	-2.35*	.58
Satisfaction	5.74 (1.41)	5.94(1.13)	-1.27	.40
Desired connectedness	5.03 (1.40)	6.04(1.00)	-6.91**	1.70
Actual connectedness	4.00 (1.52)	3.92(1.02)	.39	.09
Communication repertoire size (CRS)	3.35 (1.75)	4.10(1.50)	-3.11**	.92

**$p < .01$, *$p < .05$

Table 9

Comparing Adult children and Parent's Survey Variables for Mother

Variables	Mean and SD		Independent Samples	Effect size
	Adult children for mother	Mother for adult children	*t*- Test	Cohen's *d*
Contact Frequency	5.84 (1.24)	5.94(0.90)	-1.53	.19
Closeness	5.52 (1.28)	5.86(0.77)	-4.80**	.56
Satisfaction	6.10 (1.23)	6.49(0.88)	-5.01**	.65
Desired connectedness	5.36 (1.34)	6.36(0.88)	-11.32**	1.37
Actual connectedness	5.16 (1.37)	5.07(1.26)	.80	.12
Communication repertoire size (CRS)	4.03 (1.90)	4.96(1.94)	.87**	.82

**$p < .01$, *$p < .05$

4.5.2 Research questions

RQ1: How do distant parent-adult children manage contact over distance?

RQ 1.1: What type of technologies are used?

Adult children reported 20% of parents use older generation mobile phones and 4% parents do not use a mobile phone. Whereas 95% of parents survey participants reported using a smartphone, 4% used older generation mobile phones and 1% reported not using mobile phones**.** To understand what technologies are used by adult children and parents to maintain relationships, we examined the media use depending on the gender of parents for example adult children with father or mother and vice versa, as well as how distance and age influence the technology use. Here we report descriptive findings of popularly used technologies. The technologies that were used less than 10% of the participants were added in the 'Others' category.

Based on relationship type:

Adult Children survey:

A chi-square test of homogeneity was conducted between parent's gender (deciding relationship type) and type of technology used by adult children with their parents (see Figure 9). All expected cell counts were greater than or equal to five with the lowest expected cell count equal to 39.39 which is an adequate sample size established according to Cochran (1954). The two multinomial probability distributions were not equal in the population, $\chi 2$ (8) = 22.461, p = .004. Post hoc analysis involved pairwise comparisons using multiple z-tests of two proportions with a Bonferroni correction. Statistical significance was accepted at $p < .0005$. There were statistically significant differences in the proportion use of mobile phone with mother and father (n = 449, 20.4% versus n = 417, 23.3%), as well as use of social networking websites with mother and father (n = 185, 8.4% versus n = 99, 5.5%) $p < .0005$. There were no statistically significant differences in the proportion of other technologies used with mothers and fathers, $p > .05$.

Figure 9 shows the top four ICT reported by adult children to contact parents are mobile phone calls, instant messengers, text messaging (SMS) and audio-video calls via Skype/FaceTime. Figure shows that almost all technologies are used more with mother than with father except emails, however the difference is not statistically significant for all technologies. The chi-square test of homogeneity presented earlier shows the difference are significant in use of mobile phone and social networking sites indicating these technologies are used more with mothers than fathers. Social networking sites are different from other communication media as they are not focused on communication alone but are a form of sharing/portraying of one's life with their social network.

Parent survey:

A chi-square test of homogeneity was conducted between parent's gender and type of technology used by parents with their adult children. All expected cell counts were greater than or equal to five with the lowest expected cell count equal to 5.24 which is an adequate sample size established according to Cochran (1954). The proportion of technologies used with mothers and fathers were not statistically significantly different $\chi 2\ (8) = 4.173$, $p = .841$.

Figure 10 shows the top four ICT used by parents to contact their adult children are text messaging (SMS), mobile calling, instant messaging and emails. Similar to reported by adult children, all technologies are used more by mothers than by father to stay connected with their adult children however the difference is not statistically significant.

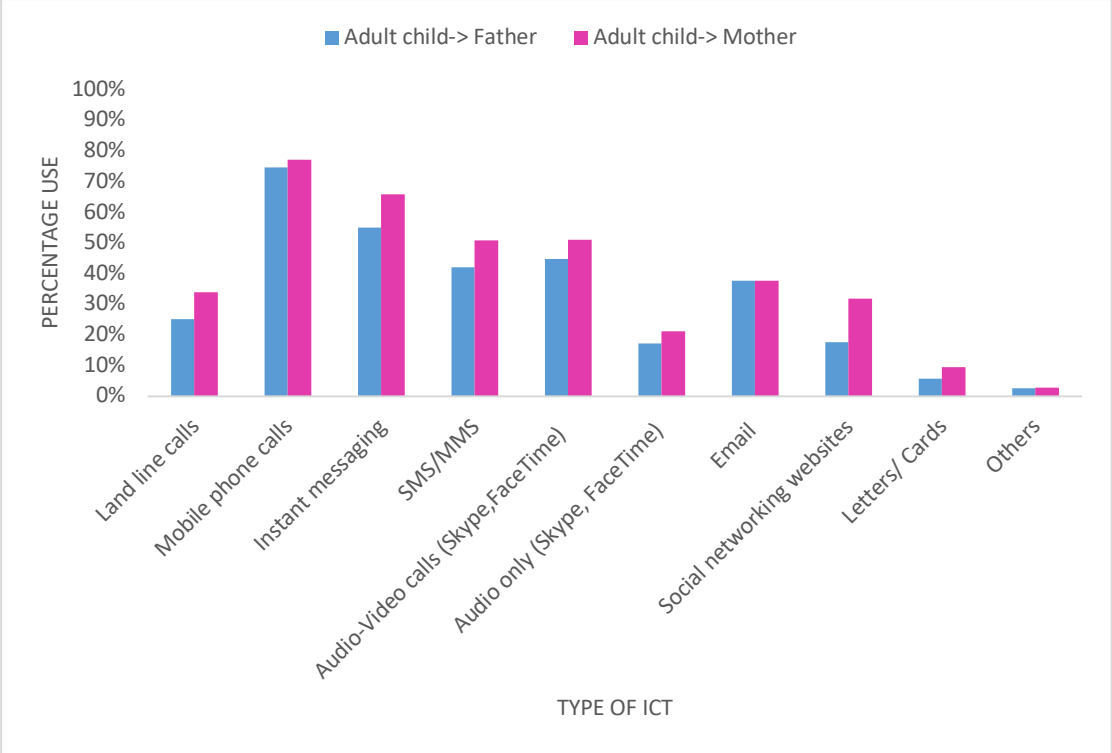


Figure 9. Adult children's Information and Communication Technology (ICT) use with father and mother

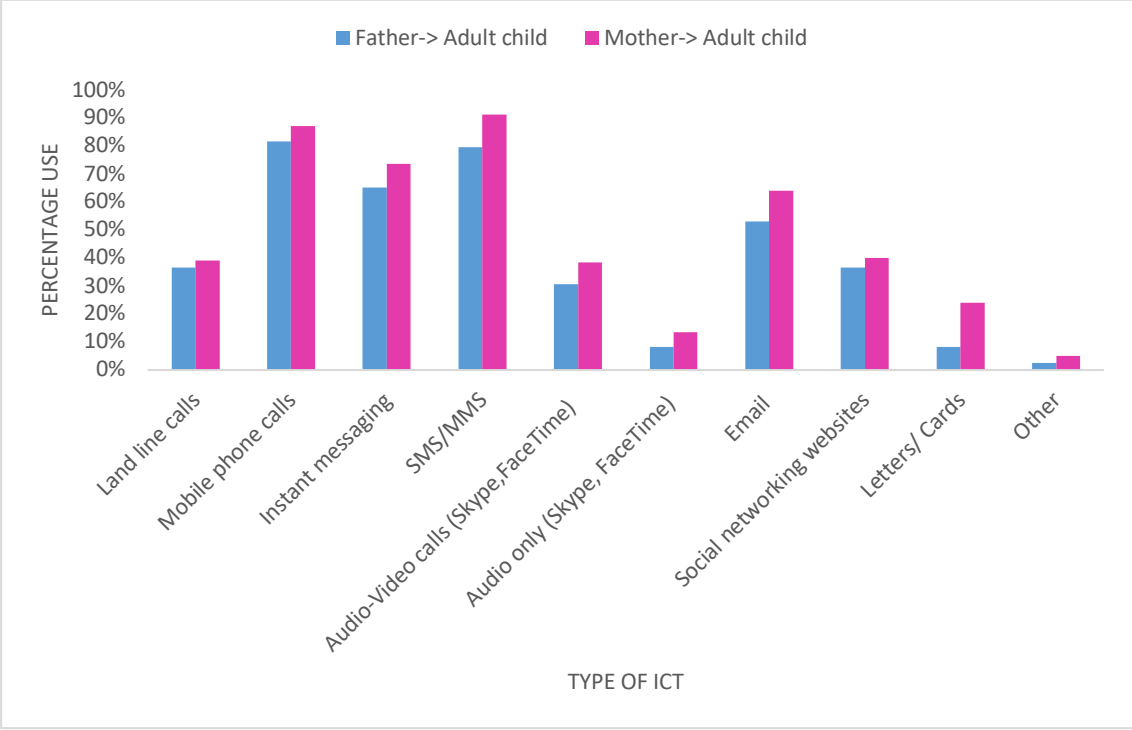


Figure 10. Parents' Information and Communication Technology (ICT) use with adult children.

Based on distance:

Adult Children survey:

We explored if there was a difference in the technologies used based on where dyads lived. As can be seen in Figure 11, adult children reported that dyads that live in the same countries as their parents, primarily use mobile phones and text messages to contact their parents. However, adult children that live in different country than their parents, use instant messaging and audio-video calls using internet to connect to their parents.

A chi-square test of homogeneity was conducted between distance (living condition) and type of technology used by adult children with their parents (see Figure 11). All expected cell counts were greater than or equal to five with the lowest expected cell count equal to 8.25 which is an adequate sample size established according to Cochran (1954). There was a significant difference in the use of technology based on distance (living condition), $\chi 2$ (16) = 119.583, $p < .001$. Post hoc analysis involved pairwise comparisons using multiple z-tests of three proportions with a Bonferroni correction. Adult children reporting using significantly less landline calls with parents when lived in different country (4.5%) compared to when lived in the same country different city (10.3%) and same city different house (15.9%), $p < .001$. They use significantly more instant messaging when lived in different countries (20.9%) compared to in same city different house (13.8%), $p < .001$. SMS/MMS are used significantly less when living in different country (7.5%) compared to when lived in the same country different city (18.1%) and same city different house (17.9%), $p < .001$. Audio-video calls using Skype/FaceTime are used significantly more when living in different countries (20.3%) compared to when lived in the same country different city (9.2%) and same city different house (3.5%), $p < .001$. Also, audio only calls using Skype/FaceTime are used significantly more when living in different country (9.1%) compared to when lived in the same country different city (3%) and same city different house (1.5%), $p < .001$. The differences were not significant for other conditions ($p > .001$).

Parent's survey:

Figure 12 shows parents reported dyad that live in the same country use mobile phone calls and SMS the most, followed by instant messaging and emails. However, dyads that live in different countries predominantly used instant messaging and audio-video calls to contact their adult children, followed by SMS and mobile phone calls.

A chi-square test of homogeneity was conducted between distance (living condition) and type of technology used by parent with their adult children. No parent participant reported using audio only calls when living in the same country different house therefore it was removed to meet the assumption of the test. All expected cell counts

were greater than or equal to five with the lowest expected cell count equal to 20.03 which is an adequate sample size established according to Cochran (1954). There was a significant difference in the use of technology based on distance (living condition), $\chi 2$ (14) = 63.099, $p < .001$. Post hoc analysis involved pairwise comparisons using multiple z-tests of three proportions with a Bonferroni correction. Parent reporting using significantly less mobile phone calls with adult children when living in different country (14.7%) compared to when living in the same country different city (20.1%) and same city different house (22.4%), $p < .001$. They also report using significantly less SMS/MMS when living in different country (15.5%) compared to when living in the same country different city (20.6%) and same city different house (22.4%), $p < .001$. They use significantly more audio-video calls (Skype/FaceTime) (16.3%) compared to living in the same country different city (7.2%) and same city different house (4.3%), $p < .001$.

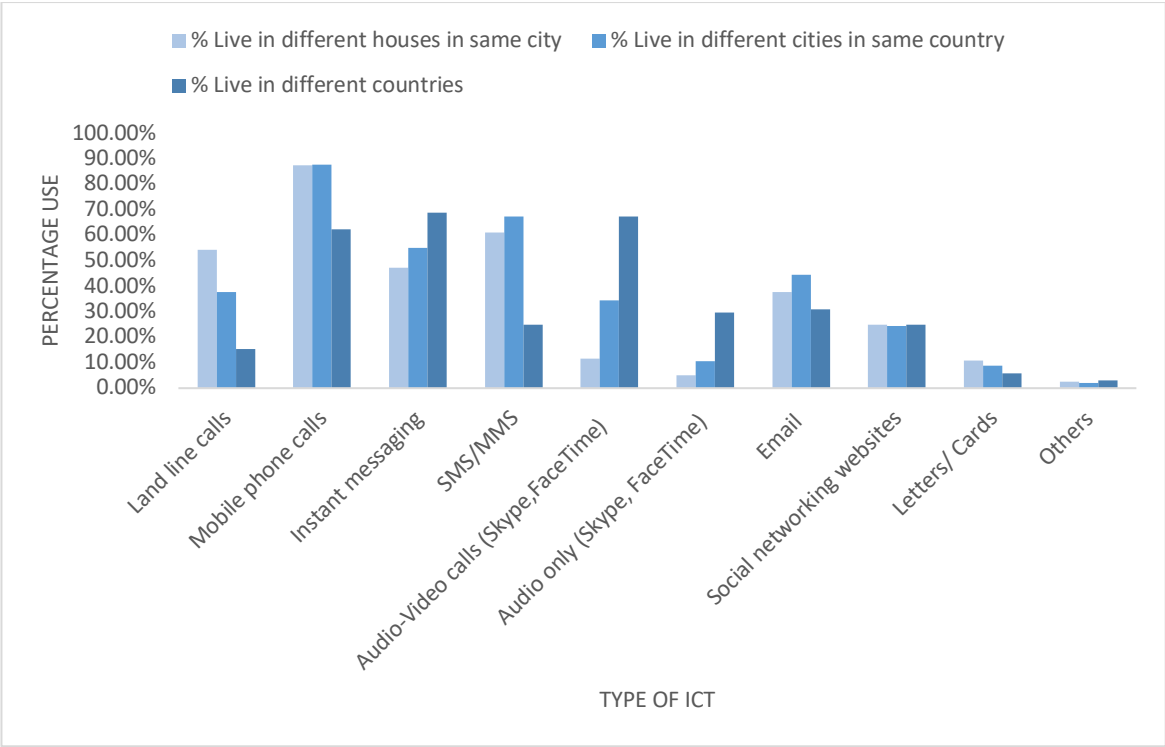


Figure 11. Adult children's Information and Communication Technology (ICT) use with parents depending on living condition.

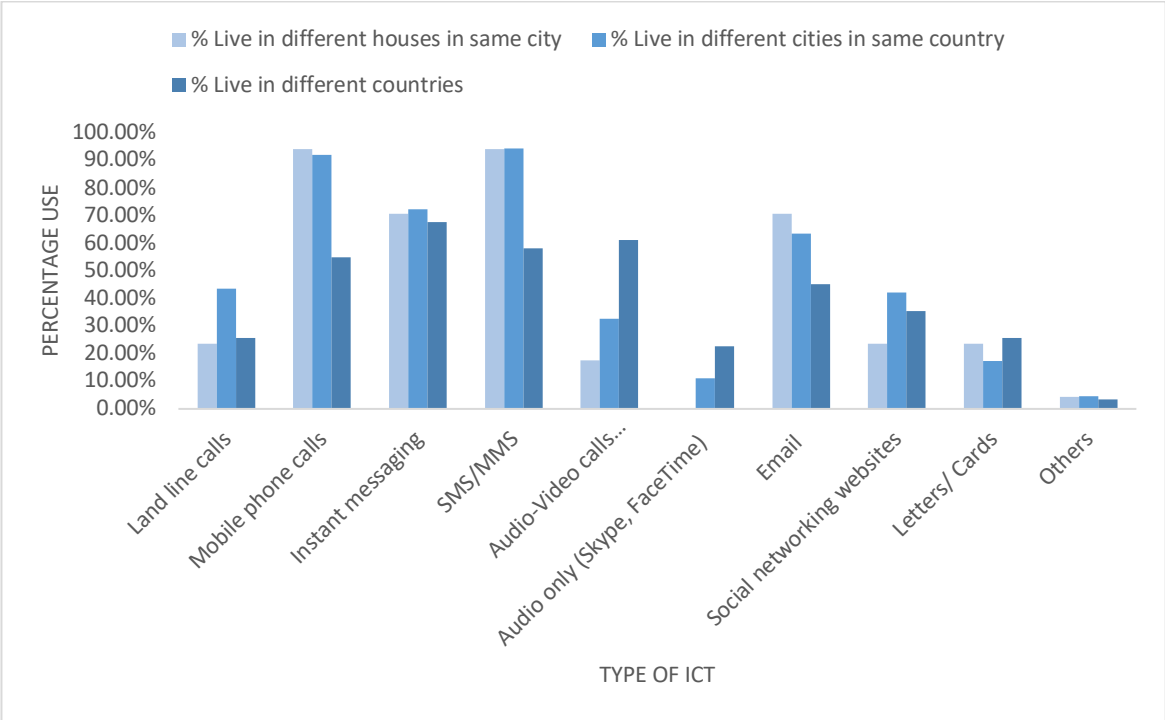


Figure 12. Parents' Information and Communication Technology (ICT) use with adult children depending on living situation.

Based on adult-child's age:

Adult Children survey:

Figure 13 shows younger generations uses primarily mobile phones, instant messaging, audio-video calls using Skype/FaceTime and SMS with their parents. The older generations use more landline, emails followed by mobile phone as well as letters/cards.

A chi-square test of homogeneity was conducted based on adult children's age group and the type of technology used by them with their parents. All expected cell counts were greater than or equal to five with the lowest expected cell count equal to 8.25. There was a significant difference in the use of technology based on adult children's age groups. $\chi 2$ (24) = 211.279, $p < .001$. Post hoc analysis involved pairwise comparisons using multiple z-tests of four proportions with a Bonferroni correction. Significantly less Young adults (18-24 years old) (3.7%) and Adulthood (25-34 years old) (7.6%) reported using landline calls with their parents compared to Middle age (35-54 years old) (18.9%) and Later adulthood (55 years and above) (22%), $p < .001$. Significantly more Young adults (18-24 years old) (20.3%) and Adulthood (25-34 years old) (18.2%) reported using instant messaging with their parents compared to Middle age (35-54 years old) (9.9%) and Later adulthood (55 years and above) (8%), $p < .001$. Similarly, significantly more Young adults (18-24 years old) (16.3%) and Adulthood (25-34 years old) (14.7%) reported using audio-video calls (Skye/FaceTime) with their parents compared to Middle age (35-54 years old) (7.1%) and Later adulthood (55 years and above) (6.8%), $p < .001$. Significantly more Young adults (18-24 years old) (7.5%) reported using audio only calls with their parents compared to Middle age (35-54 years old) (1.9%) and Later adulthood (55 years and above) (2.5%), $p < .001$. Adult children in Later adulthood (55 years and above) (18.9%) use significantly more emails with their parents compared to Adulthood (25-34 years old) (9.7%) and Young adults (18-24 years old) (9.6%), $p < .001$. They also use significantly more letter/cards (12.1%) than other age groups (4%, 1.5% and 1.3% with Middle age, Adulthood and Young adult respectively), $p < .001$.

Parent survey:

Figure 14 shows parents of all generation primarily use mobile phones, SMS, instant messaging, SMS and emails. However, parent's landline phone use seems to increase with age. Parents of older generation reported very little use of audio-video calls compared to younger generations.

With two expected cell count less than five, Fisher's exact test was conducted to compare between groups based on adult children's age and the type of technology used by parents with their adult children. The difference was not statistically significant *(*$p = .523$).

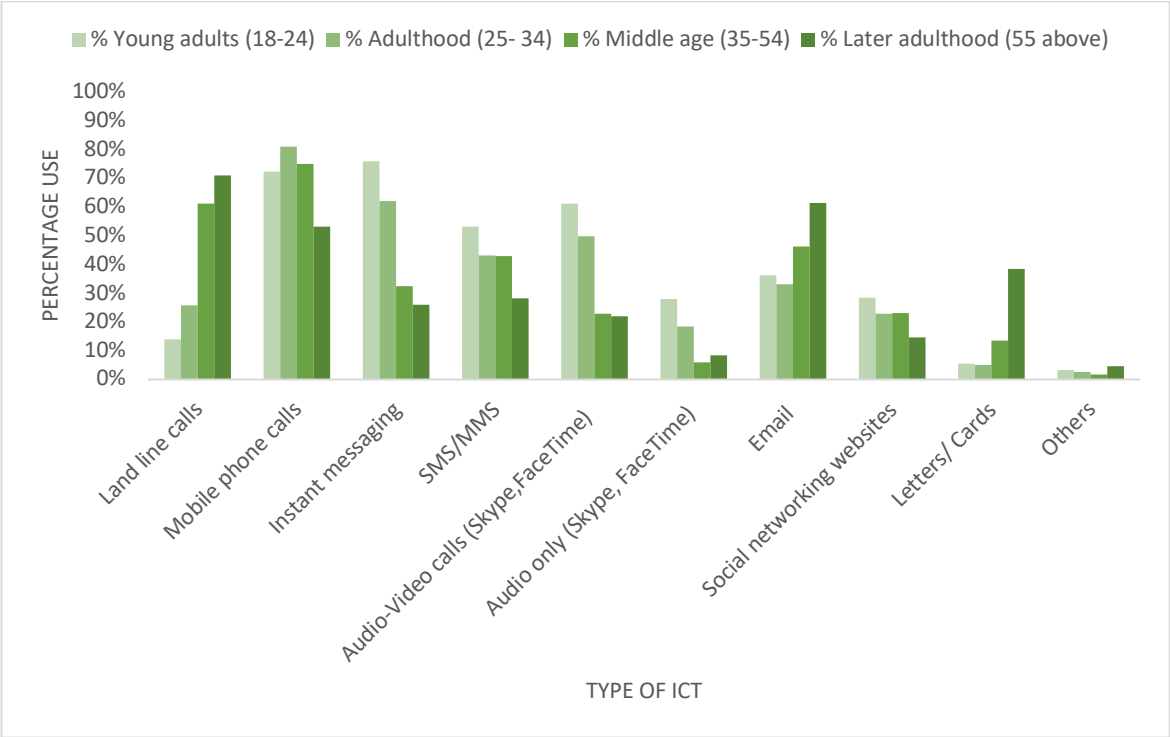


Figure 13. Adult children reported Information and Communication Technology (ICT) use depending on age.

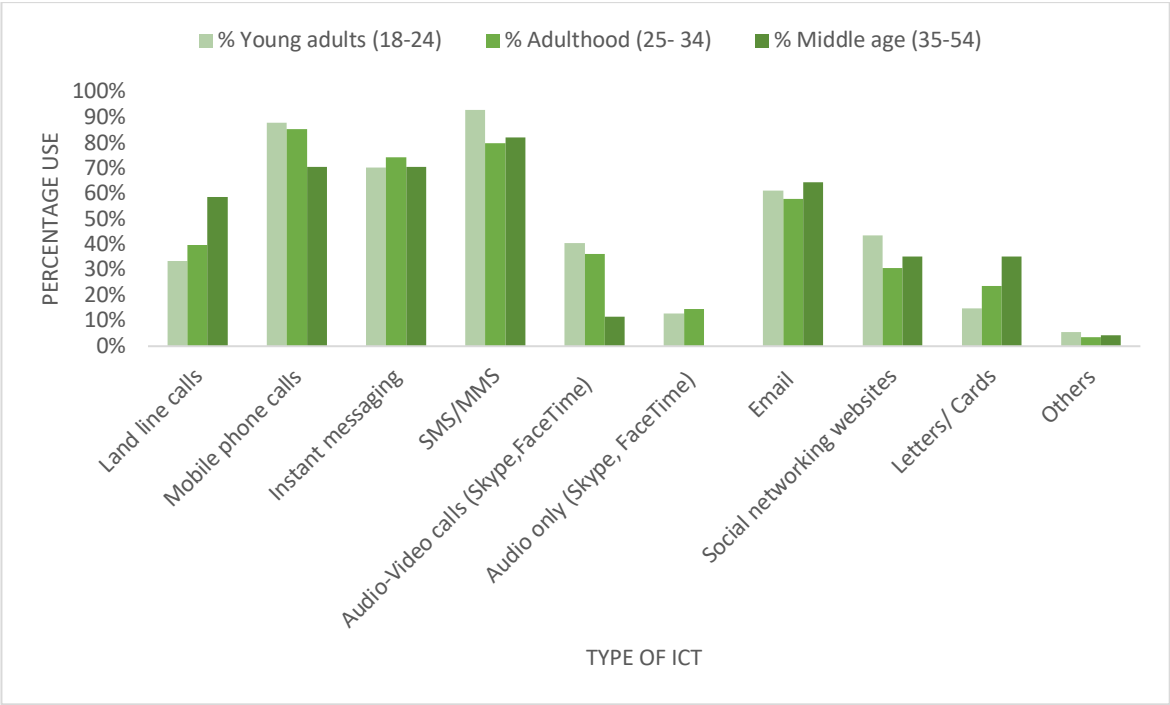


Figure 14. Parent's reported Information and Communication Technology (ICT) use depending on their adult-child's age.

RQ 1.2: How frequent is the communication between parents and their adult children?

The contact frequency was measured on 7-point Likert scale. Some adult children reported having regular contact with parents where some reported having sporadic contact. With their fathers, most adult children reported having some contact several times a week or once a week. With their mothers most adult children reported having daily contact or several times a week.

Most fathers reported having contact with their adult children several times a week or several times a month. Most mother reported talking to adult children several times a week or daily contact. The contact reported by mother was higher than contact reported by father.

Based on gender:

We explored if there a difference in the frequency of contact between mothers and fathers.

Adult children survey:

Figure 15a shows the frequency of communication between different relationship dyads (Son-father, daughter-father, son-mother, and daughter-mother) reported by adult children.

A paired sample t-test was conducted to compare the difference in the adult child's frequency of communication with their fathers and mothers. There were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out paired sample t-test was considered appropriate. The adult children's frequency of communication with fathers ($M = 5.04$, $SD = 1.48$); was significantly lower than mothers ($M = 5.84$, $SD = 1.24$); t (531) = -13.22, $p < .01$, $d = .59$.

Parent survey:

Figure 15b shows the frequency of communication between different relationship dyads (Son-father, daughter-father, son-mother, and daughter-mother) reported by parents.

A Welch t-test was run to compare frequency of contact reported by father and mother due to the assumption of homogeneity of variances being violated, as assessed by Levene's test for equality of variances ($p < .05$). There were no outliers for fathers, as assessed by boxplot. There were two different outliers for mother, however, it was decided that the outliers would not be omitted, as they were not extreme. Data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of

normality. Similar to adult children's survey, father's frequency of contact with their adult children (M =5.10, SD =1.31); was significantly lower than mothers (M =5.94, SD = .90); t (172) = -4.13, p < .01, d = 1.01.

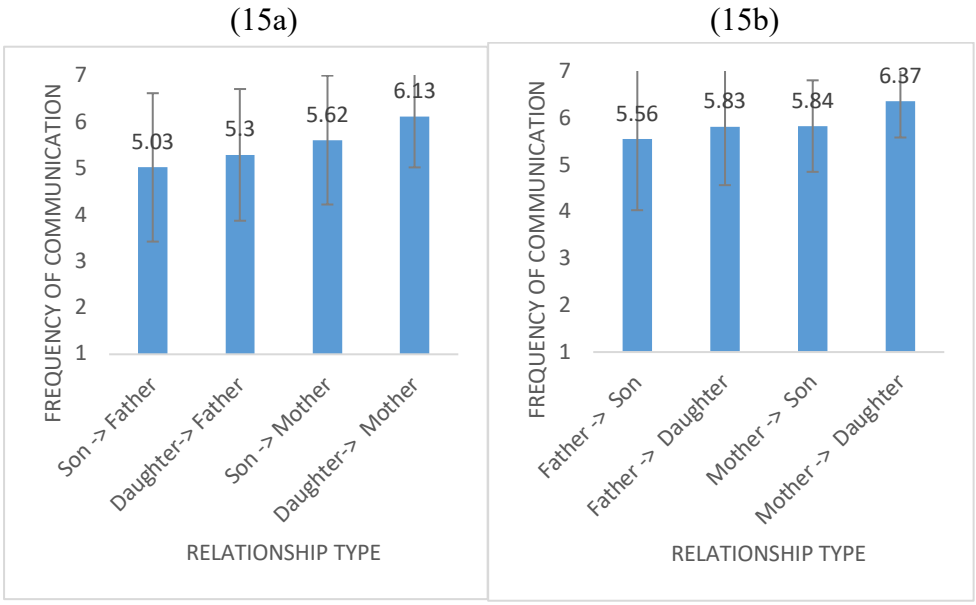


Figure 15. Adult children (15a) and parent's (15b) reported contact frequency based on relationship type.

Based on distance:

We explored if there is a difference in the frequency of contact based on where dyads live. Figure 16 shows the effect of distance between parent and adult children on their frequency of communication. A one-way between subjects ANOVA was conducted to compare the effect of living condition on contact frequency for dyads that live in same city different house, dyads that live in different cities same country and dyads that live in different country on adult children's as well as parent's data.

Adult children survey:

For contact frequency reported by adult children to their father, there were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test (p < .05); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out one-way ANOVA was considered appropriate. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .889). There was a significant effect of living conditions on contact frequency at the p < .05 level for the three conditions [F (2, 595) = 3.44, p = .032, partial η2 = .011]. Post hoc comparisons using the Tukey HSD test indicated that the contact frequency of dyads living in different city same country (M = 4.85, SD = 1.46) was significantly lower than dyads living in different country (M = 5.18, SD = 1.50, p < .05). However, the contact frequency of the dyads

living in same city different house condition (M = 5.07, SD = 1.50) did not significantly differ from the other two conditions.

For contact frequency reported by adult children with their mother, the data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out one-way ANOVA was considered appropriate. There were three different outliers, as assessed by boxplot, however, it was decided that the outliers would not be omitted, as they were not extreme. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .151). There was a significant effect of living conditions on contact frequency at the p <.05 level for the three conditions [F (2, 590) = 3.63, p = .027, partial η2 = .012]. Post hoc comparisons using the Tukey HSD test indicated that the contact frequency of dyads living in different country (M = 5.93, SD = 1.23) was significantly higher than dyads living in different city same country (M = 5.65, SD = 1.27, p <. 05). However, the contact frequency of the dyads living in same city different house condition (M = 5.86, SD = 1.14) did not significantly differ from the other two conditions.

Parent survey:

For contact frequency reported by father, there were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out one-way ANOVA was considered appropriate. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .117). There was no statistically significant difference between any of the three groups (p = .933).

For contact frequency reported by mother, data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, for the reasons mentioned earlier, carrying out one-way ANOVA was considered appropriate. There were two different outliers, as assessed by boxplot, however, it was decided that the outliers would not be omitted, as they were not extreme. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .861). There was a significant effect of living conditions on contact frequency at the $p < .05$ level for the three conditions [F (2, 122) = 3.87, p = .023, partial η2 = .06]. Post hoc comparisons using the Tukey HSD test indicated that the contact frequency of dyads living in different country (M = 5.56, SD = 0.85) was significantly lower than dyads living same city different houses (M = 6.43, SD = 0.76, $p < .05$). However, the contact frequency of the dyads living in different cities same country condition (M = 3.60, SD = 0.89) did not significantly differ from the other two conditions.

(16a) (16b)

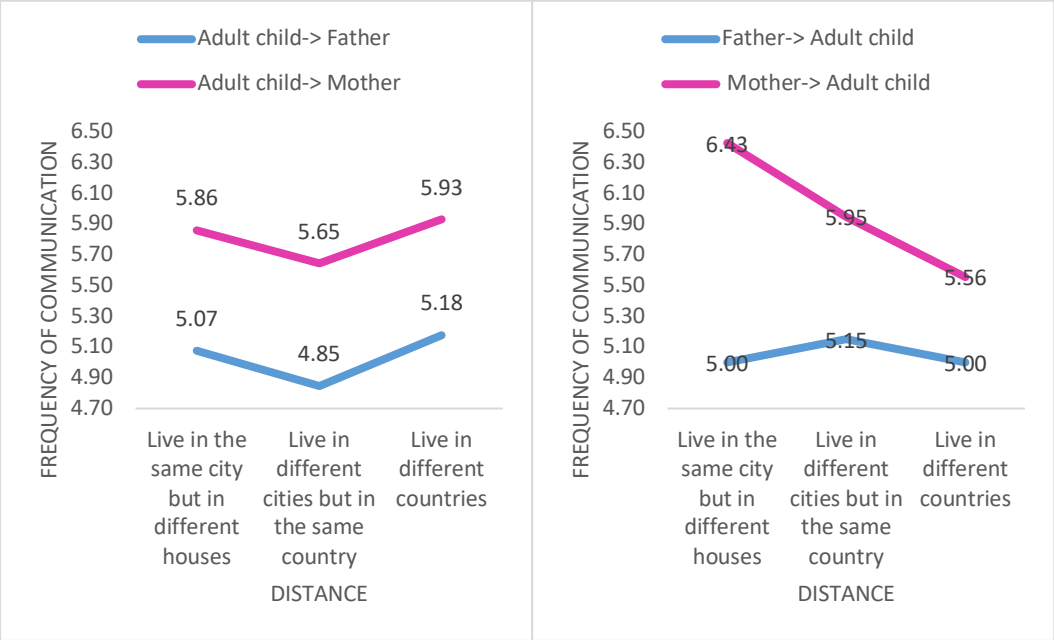


Figure 16. Effect of distance from parent on frequency of communication as reported by adult children (Figure 16a) and parents (Figure 16b).

Based on age:

We explored if there a difference in the frequency of contact between different ages groups of adult children. Figure 17 shows the differences in frequency of contact depending on the adult children's age.

<u>Adult children survey:</u>

For contact frequency reported by adult children with their father, there were no outliers, as assessed by boxplot. As assessed by Shapiro-Wilk test, data was normally distributed for Later adulthood (55 years and above) group (p = .287) but not normally distributed for other three groups (p < .05); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples. A Welch ANOVA was carried out as the data violated the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p =.001). There was a significant effect of adult children's age on contact frequency with father at the p < .05 level for the four conditions [F (3, 594) = 8.33, p <.001, partial η2 =.04]. Post hoc comparisons using the Games-Howell test indicated that the contact frequency of young adult children (18-24 years old) (M = 5.36, SD = 1.31) was significantly higher than Adulthood (25-34 years old) (M =4.88, SD = 1.60, p <.05) and middle aged (35-54 years old) adult children (M = 4.58, SD = 1.49, p< .05). Adult children in later adulthood (55 years and above) (M =4.75, SD = .86) did not significantly differ from any other conditions.

For contact frequency reported by adult children with their mother, there were no outliers, as assessed by boxplot. As assessed by Shapiro-Wilk test, data was normally distributed for Later adulthood (55 years and above) group (p = .029) but not normally distributed for other three groups (p < .05); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples. A Welch ANOVA was carried out as the data violated the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p =.001). There was a significant effect of adult children's age on contact frequency with mother at the p < .05 level for the four conditions [F (3, 589) = 16.80, p <.001, partial η2 = .079]. Post hoc comparisons using the Games-Howell test indicated that the contact frequency of young adult children (18-24 years old) (M= 6.17, SD= 1.04) was significantly higher than Adulthood (25-34 years old) (M = 5.79, SD = 1.21, p <.05), middle aged (35-54 years old) adult children (M = 5.29, SD = 1.40, p < .05) and adult children in their later adulthood (55 years and above (M = 5.00, SD = 1.55, p < .05). The difference is also significant between adulthood and middle-aged (p < .05).

Parent survey:

For contact frequency reported by father, there were no outliers, as assessed by boxplot. As assessed by Shapiro-Wilk test, data was normally distributed for all groups except Young adults (18-24 years old) (p = .001); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out one-way ANOVA was considered appropriate. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .802). There was a significant effect of adult children's age on contact frequency at the p < .05 level for the three conditions [F (2, 46) = 5.61, p = .007, partial η2 = .196]. Post hoc comparisons using the Tukey HSD test indicated that the contact frequency of fathers of middle aged (35-54 years old) adult children (M = 3.67, SD = 1.63) was significantly lower than fathers of young adults (18-24 years old) (M = 5.46, SD = 1.03, p < .05). However, the contact frequency of fathers of children in their adulthood (25-34 years old) (M = 5.00, SD = 1.31) did not significantly differ from the other two conditions.

For contact frequency reported by mother, there was one outlier, as assessed by boxplot which was not omitted as it was not extreme. Data was normally distributed for Middle age group (35-54 years old) (p = .123) but not normally distributed for each group as assessed by Shapiro-Wilk test (p < .05); however, Pallant (2013) state that ANOVA is robust to violations of normality and is more sensitive at detecting differences between samples. A Welch ANOVA was carried out as the data violated the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p > .05). No significant difference was found between any three conditions (p = .118).

(17a) (17b)

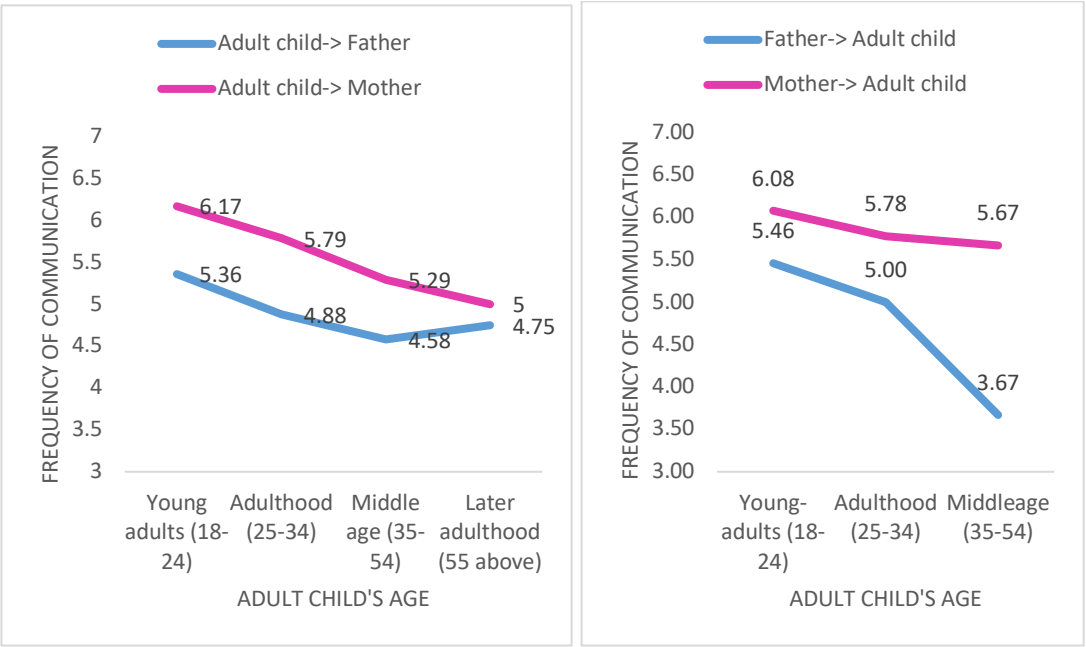


Figure 17. Effect of adult-child's age on frequency of contact as reported by adult-child (Figure 17a) and parent (Figure 17b).

RQ 1.3: How many total numbers of technologies are used by parents and adult children and if there are differences between mothers and fathers?

The average number of technologies used by adult children to communicate with others was 6.77 out of the 13 options provided (See appendix C Section 10.4.2 for the details of all 13 technologies). The average number of technologies used by adult children to communicate with their parents was 3.69 (*SD* = 1.82)

The average number of technologies reported by parents was 7.03 (*SD* = 2.35) out of 13. The average number of medias used by parents to communicate with their adult children was 4.53 (*SD* = 1.72). As mentioned before the number of technologies are also referred as communication repertoire size (CRS).

To examine whether there was a difference in adult children's CRS with their parents, a paired sample t-test was conducted on the adult children's survey data. There were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out paired sample t-test was considered appropriate. There was a significant difference in the score for CRS for father ($M = 3.35$, $SD = 1.75$) and mother ($M = 4.03$, $SD = 1.90$) condition; $t\ (531) = -7.842$, $p < .01$, $d = .35$. This suggest the number of medias used to communicate with father is significantly lower than number of medias used to communicate with mother however effect size indicates that the difference is trivial.

To examine whether there was a difference in parents CRS with their adult child, an independent samples t-test was conducted on the parent's survey data. There were no outliers, as assessed by boxplot. As assessed by Shapiro-Wilk test, data was normally distributed for father (p = .028) but not for mother (p = .001); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out independent sample t-test was considered appropriate. There was the homogeneity of variances, as assessed by Levene's test of homogeneity of variances (p = .058). There was a significant difference in the score for CRS of father (M = 4.10, SD = 1.50) and mother (M = 4.96, SD = 1.94); t (172) = -2.788, p < .01, d = .51. This suggest the number of medias used by father to communicate with their adult children is significantly lower than mothers with a moderate effect size.

RQ 1.4: Is there a relationship between the number of medias used and connectedness, closeness and relationship satisfaction?

There was a strong positive correlation between CRS and connectedness, closeness and relationship satisfaction reported by adult children for both parents (see table 10 and 11). Similarly, for the parent's survey, data reported by mothers showed positive correlation between CRS with connectedness, closeness and relationship satisfaction (see table 12). However, there was no association between these variables reported by fathers (see table 13).

Table 10

Adult children Survey: Correlations among Key Study Variables for Father (N = 598)

Variables	2	3	4	5	6
1. Contact Frequency	.527**	.458**	.331**	.497**	.226**
2. Closeness	--	.722**	.574**	.594**	.234**
3. Satisfaction		--	.381**	.459**	.186**
4. Desired Connectedness			--	.602**	.160**
5. Actual Connectedness				--	.202**
6. CRS					--

Notes. ** Correlation is significant at the 0.01 level (2-tailed). CRS = Communication Repertoire Size.

Table 11

Adult children Survey: Correlations among Key Study Variables for Mother (N=612)

Variables	2	3	4	5	6
1. Contact Frequency	.498**	.345**	.400**	.512**	.149**
2. Closeness	--	.684**	.680**	.573**	.209**
3. Satisfaction		--	.490**	.400**	.147**
4. Desired Connectedness			--	.667**	.204**
5. Actual Connectedness				--	.204**
6. CRS					--

Notes. ** Correlation is significant at the 0.01 level (2-tailed). CRS = Communication Repertoire Size.

Table 12

Parents' Survey: Correlations among Key Study Variables of Father (N=49)

Variables	2	3	4	5	6
1. Contact Frequency	.389**	.281	.082	.140	.169
2. Closeness	--	.648**	.152	.238	.255
3. Satisfaction		--	.104	.249	.274
4. Desired Connectedness			--	.082	-.309*
5. Actual Connectedness				--	.129
6. CRS					--

Notes. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). CRS = Communication Repertoire Size.

Table 13

Parents' Survey: Correlations among Key Study Variables of Mother (N=125)

Variables	2	3	4	5	6
1. Contact Frequency	.399**	.254**	.047	.349**	.169
2. Closeness	--	.569**	.269**	.587**	.285**
3. Satisfaction		--	.063	.401**	.193*
4. Desired Connectedness			--	.264**	.070
5. Actual Connectedness				--	.312**
6. CRS					--

Notes. ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). CRS = Communication Repertoire Size.

RQ2: What value does connectedness have for this particular relationship?

RQ 2.1: Is there a relationship between connectedness and closeness or relationship satisfaction?

Tables 10, 11 and 13 shows strong positive correlation between actual connectedness and closeness as well as actual connectedness and relationship satisfaction for adult children with both parents and by mothers with their adult children. However, there was no association between these variables reported by fathers (see table 12).

RQ 2.2. Do distant parents and adult children desire more connectedness than they actually have?

Adult children survey:

For adult children that do not live with their father, a paired-samples t-test was conducted to compare adult children's desired connectedness (DC) to their actual connectedness (AC) with father. There were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out a paired-samples t-test was considered appropriate. There was a significant difference in the score for AC for father (M= 3.98, SD= 1.54) and DC for father ($M = 4.98$, $SD = 1.44$) condition; t (598) = 17.79, $p < .01$, $d = .73$. This suggested the adult children's desired connectedness with fathers was significantly higher than their actual connectedness to their father and the large effect size shows the significance of results.

A paired-samples t-test was conducted to compare adult children's desired connectedness to actual connectedness with their mother. There were no outliers, as assessed by boxplot; data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out a paired-samples t-test was considered appropriate. There was a significant difference in the score for AC ($M = 5.07$, $SD = 1.42$) and DC ($M = 5.26$, $SD = 1.37$ for mothers) condition; t (591) = 3.851, $p < .01$, $d = .16$. Although these results showed the difference between adult children's desired connectedness and actual connectedness for mother is statistically significant, with the low effect size.

Parent's survey:

A paired-samples t-test was conducted to compare father's desired connectedness (DC) to their actual connectedness (AC) to their adult children. There were no outliers, as assessed by boxplot; data was normally distributed for each group as assessed by Shapiro-Wilk test ($p > .05$). There was a significant difference in the score for father's DC ($M = 6.04$, $SD = 1.00$) and their AC ($M = 3.92$, $SD = 1.02$) condition; t (49) = 10.71, $p < .01$, $d = 1.53$. This suggested that a father's desired connectedness to their adult children is significantly higher than their actual connectedness to their adult children and the large effect size shows the significance of results.

A paired-samples t-test was conducted to compare mother's desired connectedness (DC) to mother to their actual connectedness (AC) to mother. There were three

different outliers for mother's DC and two different outliers for mother's AC however, it was decided that the outliers would not be omitted, as they were not extreme. Data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality and is more sensitive at detecting differences between samples therefore carrying out a paired-samples t-test was considered appropriate. There was a significant difference in the DC score ($M = 6.36$, $SD = .81$) and AC ($M = 5.07$, $SD = 1.26$) condition; $t\ (125) = 10.36$, $p < .01$, $d = .93$. This suggested that mother's desired connectedness to their adult children is significantly higher than their actual connectedness to their adult children and the large effect size shows the significance of results.

As a part of the investigation of whether adult children and parent desire more connection than they actually have, we also asked participants to choose how they felt about their contact with their mother/father/daughter/son. Whether they were happy with the contact they usually had, if they wished that they had more contact than they usually had or if they wish they had less contact than they usually had. Approximately 37% of adult children that do not live with their parents wanted more contact with father and 25% wanted more contact with mother (see Figure 18).

Approximately 49% father and 25% mother wanted more contact with their adult children than they usually have. No father nor mother wished that they had less contact than they usually had (see Figure 19).

(18a) (18b)

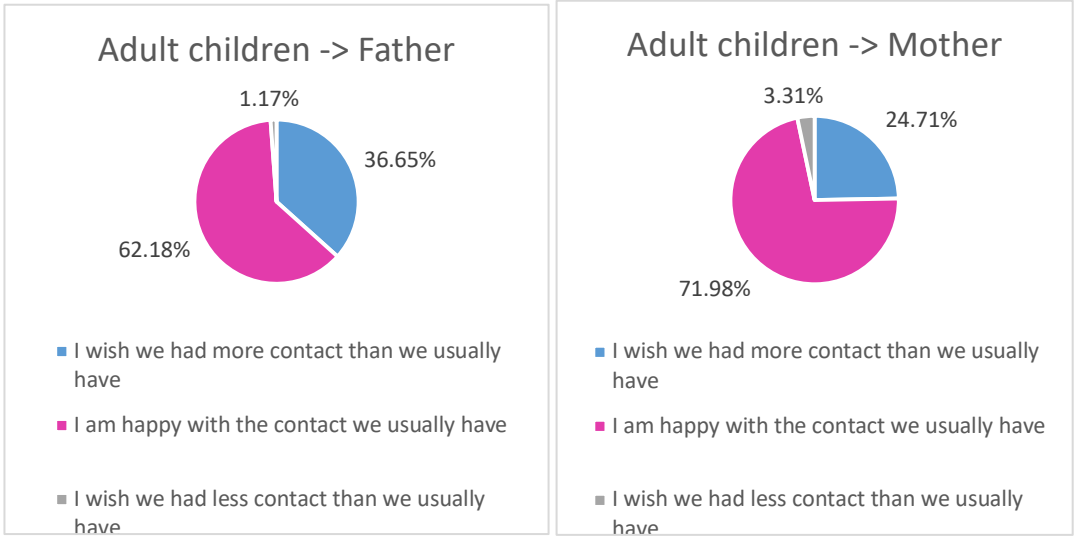


Figure 18. Adult children's desire for contact with their father (Figure 18a) and mother (Figure 18b)

(19a) (19b)

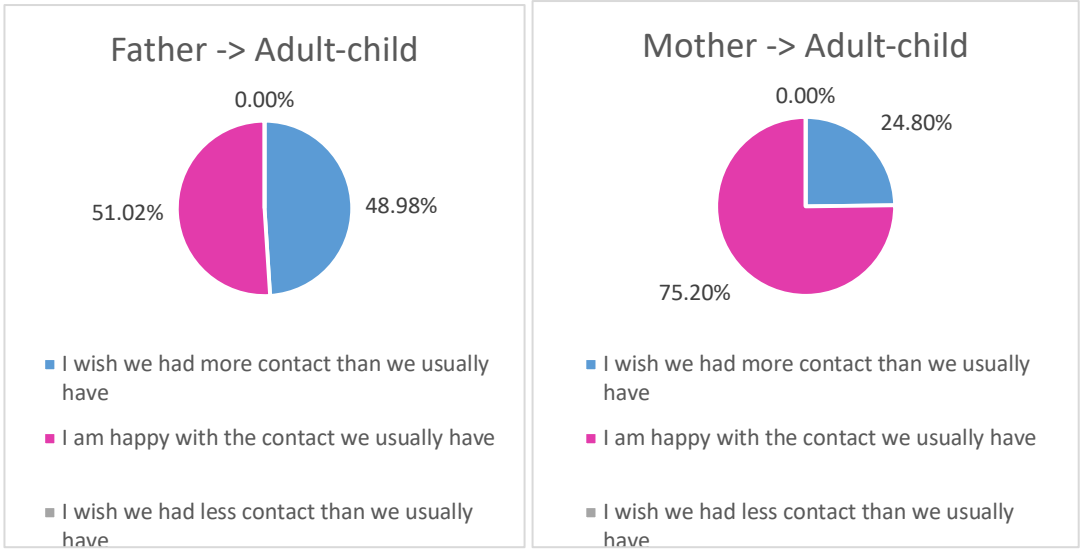


Figure 19. Fathers (19a) and mothers (19b) desire for contact with their adult children.

RQ 2.3: Is there a difference between desired connectedness of adult children and desired connectedness parents?

A Welch t-test was run to compare adult children's desired connectedness (DC) to their father and fathers desired connectedness for their adult children due to the assumption of homogeneity of variances being violated, as assessed by Levene's test for equality of variances (p = .008). There were no outliers, as assessed by boxplot;

data was normally distributed for fathers desired connectedness as assessed by Shapiro-Wilk test ($p > .05$) but not normally distributed for adult children's desired connectedness to father ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality. There was a significant difference in the score for adult children's DC ($M = 5.03$, $SD = 1.40$) and fathers DC ($M = 6.04$, $SD = 1.00$) condition; t (638) = -6.91, $p < .01$, $d = 1.70$. This suggested that parents' desired connectedness to their adult children is significantly higher than adult children's desired connectedness to their parents and the large effect size shows the significance of results.

A Welch t-test was run to compare adult children's desired connectedness (DC) to their mother and mothers desired connectedness for their adult children due to the assumption of homogeneity of variances being violated, as assessed by Levene's test for equality of variances ($p < .05$). There were no outliers for adult children's DC for their mother but three different outliers for mother's DC for their adult children however, it was decided that the outliers would not be omitted, as they were not extreme. Data was not normally distributed for each group as assessed by Shapiro-Wilk test ($p < .05$); however, Pallant (2013) state that t-test is robust to violations of normality. There was a significant difference in the score for adult children's DC ($M = 5.36$, $SD = 1.34$) and mothers DC ($M = 6.36$, $SD = 0.88$) condition; t (709) = -11.32, $p < .01$, $d = 1.37$. This suggested that parents' desired connectedness to their adult children is significantly higher than adult children's desired connectedness to their parents and the large effect size shows the significance of results.

RQ 3: What do physically distant parents and adult children miss and what are their needs?

This was one of the questions asked in the online survey and participants were given seven options and an 'other' option. As can be seen in Figure 20 and Figure 21, the most important things adult children as well as parents reported that they missed were their adult children/parent's presence and knowing that they are okay. Few participants that chose the 'other' option reported missing mother's food. They also reported missing discussing things with father other than daily activities such as news, politics and history.

Adult children survey:

To compare if the differences for mother and father were statistically significantly different, a chi-square test of homogeneity was conducted on the data reported by adult children. The difference was not significant for mother and father ($p = .052$).

Parent survey:

With four expected cell count less than five, Fisher's exact test was conducted on the data reported by parents which indicated the differences were not statistically significant ($p = .292$).

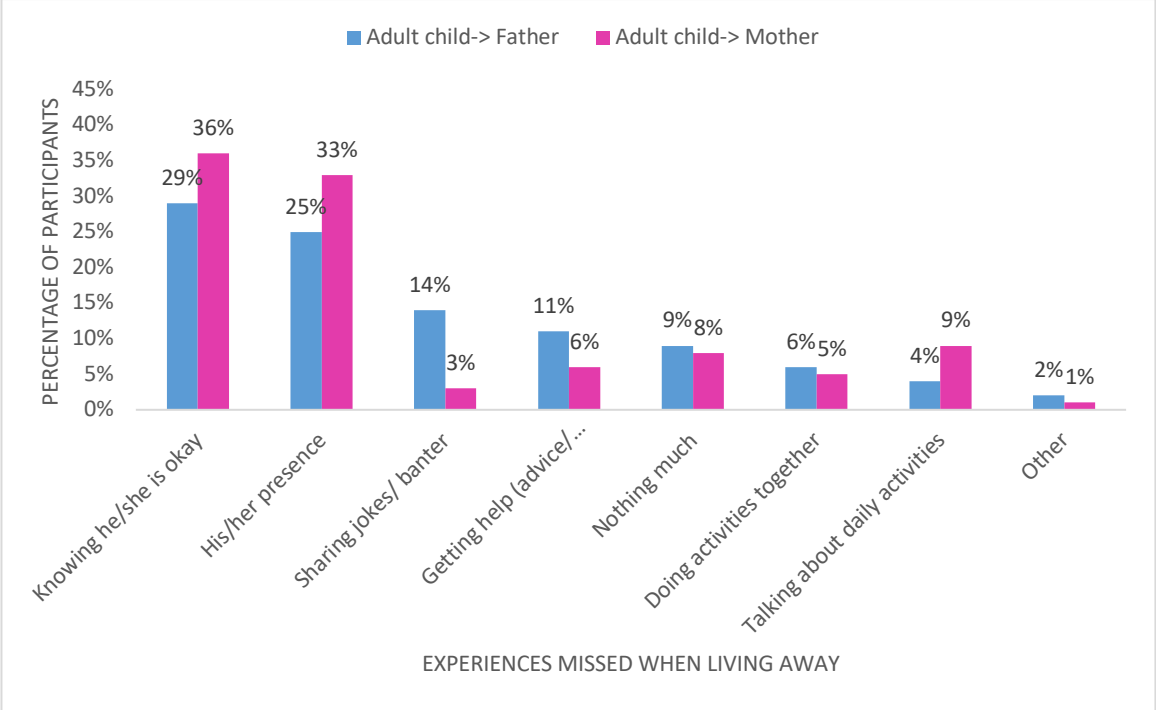


Figure 20. Experiences adult children miss/need when living away from their father and mother.

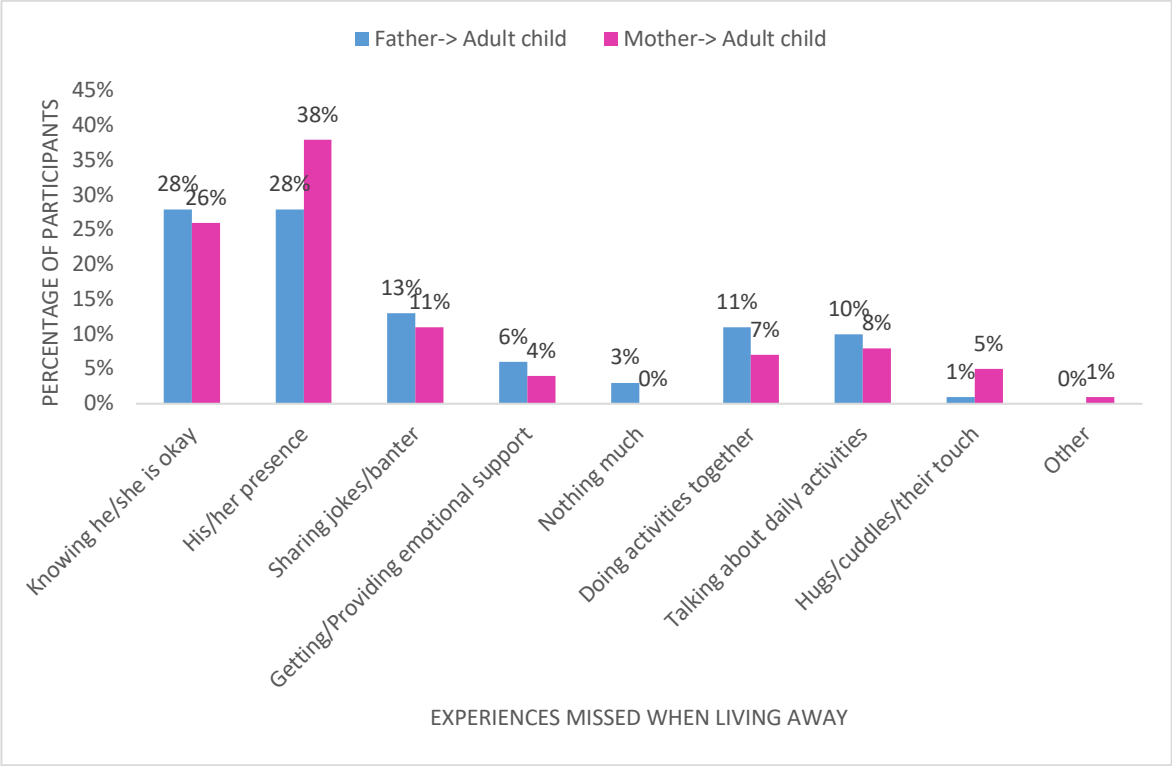


Figure 21. Experiences parents miss/need when living away from their adult children.

4.5.3 Qualitative findings

To supplement our quantitative data, we asked participants the following questions,

- Please tell us more about how you and your father/mother/son/daughter maintain your relationship with each other when you are apart?
- Can you tell us a bit more about how you and your father/mother/son/daughter use current technologies (phone, instant messenger, emails etc.) to maintain contact with each other?
- Can you think of any other way that you would like to connect to your father/mother/son/daughter? Can you suggest what it may be?

The qualitative data from quotes was analysed using thematic analysis (Braun et al., 2014). We analysed quotes from the adult children's survey separately to parent's quotes. Many similarities were found between the themes. Additionally, parents and adult children mentioned complimentary opinions within themes therefore we combined these themes.

Cost and reliability:

Most participants that responded to the open-ended questionnaire mentioned that they would like to see each other in person more often, however this can be difficult due to distance and cost of travel. Some participants complained about not being able to use phone calls as much as they want as the cost of calling can be high in different countries. A daughter wrote,

> *"I would like to be able to talk on the phone more, but the cost is too high."- A daughter*

Reliability was another important reason for using a media. Some adult children mentioned that they would like to use media which is cheap and reliable. A daughter wrote,

> ***"****Cheaper and more reliable (Unlike Facebook and WhatsApp calls) phone calls would be better."- A daughter*

Differences in contact based on relationship type:

Complimentary to our quantitative findings, there were distinct differences in contact between dyads based on their gender. Females (mother, daughter) were more communicative and were more likely to keep in touch whereas males (son, father) were reported not as communicative and did not initiate contact. For example, adult children mentioned having a lot more contact with their mother than with their father. With fathers, many participants mentioned having occasional quick contact which most of the time is for specific, practical or instrumental information exchange. A participant said,

> *"Brief chat with my Dad. Occasional emails to share specific information."- A son*

On the other hand, with mothers, participants mentioned having more contact to keep each other updated or just to keep in touch. A participant mentioned,

> *"I try to arrange a call with them roughly every week and see them about 4 times a year. My mum will send me cards occasionally and messages me frequently just to say hello or let me know she is thinking of me" -A daughter*

Many adult children mentioned not having direct contact with their father but communicated via mother. A participant said about her communication with father,

> *"[We talk] mainly via my mother - she chats on the phone and passes on the information to him" -A daughter*

Many parents mentioned that their son is not very communicative. Whereas, they mentioned having frequent contact with daughters. For example, a mother mentioned about her daughter,

> *"Daughter is at university I like to maintain a high level of contact to reassure myself that she is ok. She is not far away from home, so she visits regularly." – A mother*

Another mother mentioned about her son,

> *"He tends not to communicate unless he needs something (!) but I feel this is probably completely normal for a young man of his age. If he has time, he is always happy to chat when I call, and although I don't want to reduce his independence or affect his new life away from home, I do feel it is important to maintain contact."- A mother- A mother*

Communication dependency on parent's use of ICT:

Adult children seemed to choose the channel of communication depending on the technologies that their parents were able and willing to use. Adult children reported that they wanted to use some other, more advanced technologies but could not as their parents could not or would not use them. A son wrote,

> *"I would use skype, but my mother is not so keen on it."- A son*

Many adult children reported that they would like to speak more often on phone and especially use Skype/FaceTime with parents. However, they complained about the parent's ability and unwillingness to use these technologies. For example, a participant wrote about their mother,

> *"I would like to connect with her on WhatsApp and messenger/Facebook, but she doesn't use these media" – A daughter*

Adult children reported 24% parents not using smartphones which may hinder their ability to connect to one another. Also, many adult children mentioned that they would like to connect with their parent using various other ICT however their parents were not "technologically savvy".

In the parent's survey, approximately 94% of participants used a smartphone and on average used 7 different communication technologies. Although most parents that participated in our survey used modern ICTs to communicate with one another, there were a few parents that mentioned they used an old generation phone and hence only relied on text messages to connect with their adult child. A mother mentioned,

> *"It is usually by text principally because I have an old-fashioned mobile phone." –A mother*

Both adult children and parents reported using multiple mediums to connect with one another depending on their need and recognised the benefit of technologies for maintaining their relationship. WhatsApp was one of the main mediums mentioned by most participants. Family group chat via WhatsApp was quite popularly used to keep in touch with multiple people in a family, including parents. Other prevalent methods of communication were mobile phone calls, SMS and occasional emails. A mother mentioned,

> *"I love the fact that we can message either SMS, MMS, messenger. WhatsApp the daily things that happen. Sometimes we email and send links to each other about things we have seen or going to do or our birthday, Christmas lists or tickets for gigs. We Skype usually monthly sometimes more depends on what's happening. We use Facebook to send pictures and keep in contact he has a twitter account, but I don't as gives him still some privacy with his friends as that is important to us. We use our mobile phones, laptops, pc and tablets also use land line. Technology has improved our relationship"-A mother*

Parents do not want to disturb:

This was one of the main themes where parents mentioned they are careful about contacting their adult children as they do not want to feel that they are intruding in their adult-child's busy life. This was recognised by adult children where they mentioned being aware of parents not wanting to disturb them. A daughter mentioned,

> *"They normally don't call me unless we've arranged a call as they don't like to disturb me."- A daughter*

Parents would use an ICT that they thought was least intrusive. For example, a mother explained the reason she uses text messages to contact her son,

"I think texting provides the least intrusive communication."- A mother

It is possible that a few adult children may feel disturbed by their parents, especially mothers. For example, a daughter mentioned,

"It would be lovely if she could tell how busy I am before calling."- A daughter

Reassurance about well-being:

Reassurance was one of the main themes mentioned by many parents. Parents contacted their adult children to know about their wellbeing and physical safety. A mother mentioned,

"I text her just to reassure myself that she is ok, especially with regards to her safety e.g. If she is out at night or visiting somewhere new."-A mother

A parent mentioned her daughter desires parent's presence as a reassurance without intrusion. The mother mentioned,

"(Daughter) likes us to be there as a reassuring background presence rather than interfering in her adventures & learning." –A mother

Following life/Keeping each other updated:

Parents also mentioned that they like to see what their adult children are up to. A mother mentioned,

"I love her (daughters) snapchats the most as I feel I can 'see' what's she's up" –A mother

Many mothers mentioned that the family uses group chat to keep everyone updated of things happening in their lives. A mother mentioned,

"We have a family WhatsApp account just so we all can see hear what is going on. We message each other separately with more personal messages."- A mother

Doing things together:

Some participants mentioned that they would like to do more things together such as cooking, traveling, doing shared hobbies. A daughter wrote,

"I would like a tech friendly way that we could connect while doing activities that we both like (e.g. cooking) and do them together. It could be like a simple push to talk video call system

that would be portable around the house. Simplicity is the key here, so it would have to be a dedicated system."- A daughter

A mother mentioned,

"FaceTime is good as we can see each other. Sometimes she has it on as she's doing other tasks, e.g. sorting her washing, so we're chatting as if we were in the same room but without the intensity of a phone call."- A mother

Seeing, feeling the presence:

Desire to see each other was one of the main things mentioned by both adult children and parents. Many reported wanting to use more Skype/FaceTime with each other. A few adult children and parents suggested some interesting novel ways that they would like to use to connect to their parents. For example, they mentioned they would like to use virtual reality, augmented reality, and family focused social media applications. A daughter mentioned,

"Maybe we could Skype more often and use virtual reality to see each other almost as if the person is next to you."- A daughter

Some parents mentioned that they miss the presence of their adult child. A mother mentioned,

"When we are apart, we don't feel the need to chat every day, however we do miss each other's presence" –A mother

4.6 Discussion

In this study, we explored how parents and adult children use technologies to maintain relationships over distance, what value connectedness has in these relationships and what their needs are when living away from each other. In this section, we discuss the findings of both the adult children and parents' surveys. We discuss our quantitative and qualitative findings in the context of our various research questions.

4.6.1 Parent's and Adult children's ICT use

We found that variations in technology use were linked to the relationship type (gender), living locations (distance) and age of users. These were driven by the varying desirability of ease of use, reliability and cost of using the technologies between the different users.

We found that adult children mainly used mobile phone, instant messaging followed by SMS and audio-video calls to keep in touch with their parents whereas parents reported using mobile phone and SMS as two main ICTs followed by instant messaging and emails to keep in touch with adult children. Previous studies have

also found mobile phones and SMS as two of the main ICT used for maintaining relationships over the distance with their parents (Ramsey et al., 2013; Schon, 2014; Tee et al., 2009). The differences in technologies reported by parents and adult children reflect the fast changing landscape of ICT use which is also reported by (Madden et al., 2010). Indeed, previous studies which report emails and SMS as second popular media choices, also reported a decrease in email use between adult children and their parents (Ramsey et al., 2013).

Difference based on relationship type (gender)

ICT use:

The descriptive data of types of ICT used showed that adult children used slightly more ICTs with mother, than with father although these differences were not significant. The difference was statistically significantly more in the use of mobile phones with mother compared to father. Similarly, the use of social networking websites with mothers was significantly more than with fathers. This could be because females tend to use more social media than men (Correa, Hinsley, & De Zuniga, 2010). Also, Duggan, Lenhart, Lampe, and Ellison (2015) found "Mothers are heavily engaged on social media, both giving and receiving a high level of support via their networks." Mothers and fathers reported a similar ICT usage to the adult children although the differences were not significant.

Frequency of contact:

The overall frequency of contact reported by adult children with both father and mother was high. Mothers and fathers also reported high frequencies of contact. Previous studies have also found that adult children and parents stay in frequent contact (Fingerman et al., 2012). The contact frequency with mothers however, was significantly higher than fathers. There is a strong gendered dimension to intergenerational contact which has been consistently found in previous studies and is also supported by our results (Grundy & Shelton, 2001). Consistent with the previous findings, we found that the contact with mothers is higher than with fathers with mother-daughter relationships reporting highest and father-son relationships reporting the lowest frequency of contact (Fingerman et al., 2012; Lye, 1996; Schon, 2014). Also, daughters keep more contact with parents than sons. This could be explained with gender theory which suggests woman are more involved in adult child–parent relationships because they often give higher importance to close emotional bonds with family members (Silverstein, Parrott, & Bengtson, 1995) and exhibit more compassionate and altruistic behaviours than their male counterparts (Beutel & Marini, 1995; Lye, 1996; Tao, 2014)

Difference based on living locations of dyads

ICT use:

The use of ICT to contact parents was very different between adult children that lived in the same country to the ones that lived in different countries. Adult children that lived in the same country as their parents predominantly used mobile phones,

and SMS/MMS. There was no difference in the types of ICT used between adult children that lived in same city or different cities in same country except for audio-video calls (Skype, FaceTime). However, adult children that lived in different countries predominantly rely on instant messenger and audio-video calls via Skype/FaceTime to maintain relationships followed by mobile phone calls. This could be because of the high cost of international cellular calls and SMS/MMS. Boneva et al. (2001) also found that while individuals relied on phone calls to stay connected with local friends and relatives, internet-based channels were more effective in long-distance relationships. As was reported by adult children, distance was an important factor in determining parents' ICT usage. The most marked difference was again the significantly higher use of audio and video calls over the internet for parents living in different countries compared to the parents living in the same countries to their children. The use of mobile phone calls and SMS was significantly less for the parents living in different countries compared to the parents living in the same countries to their adult children. As mentioned earlier, this could also be because of high cost of international cellular calls and SMS. Parents that lived in different countries to their adult children mainly used instant messenger, Skype/ FaceTime closely followed by SMS and phone calls.

There is an exponential increase in internet users across the globe and most of the communication applications such as WhatsApp, Facebook messenger, Skype/FaceTime are free to use (ITU, 2017). These applications still need internet connectivity which is not as reliable as a cellular network hence this might explain why mobile phones are still the third most popular ICT used by dyads living in different countries. Additionally, as the *frequency* these individual technologies were being used was not assessed; people living in different countries may have selected mobile phones even if they only used it occasionally as a replacement during an internet outage.

Frequency of contact:

There was no significant difference between the dyads that live in the same city but different houses to different cities in same country. The difference in frequency of contact between people that lived in a different country was significantly higher than the ones that lived in same country. This could be because adult children that move to a different country may struggle with differences in culture or experience loneliness, which may lead them to seek familiarity and support by regularly contacting their parents. Most previous studies that include parent-adult child relationship living in different countries are qualitative and do not quantitatively measures frequency of contact (Neustaedter et al., 2015; Tee et al., 2009). To our knowledge, there is no other study that quantitatively measures and compares the contact frequency of parent-adult child dyads that are living in different countries to the ones living in the same country.

Unlike the adult children responses, mothers reported a monotonic decrease in contact frequency as the distance between them and their child increased. Unlike adult children there was no increase in contact frequency reported by parents when they were living in different countries to living in different cities in the same country as their adult children. This might initially seem counter intuitive in light of the arguments presented in the previous paragraph, which discussed why children reported an increase in contact frequency when moving abroad. However, participants didn't directly measure their contact frequency but rather reported what they *felt* it was. Adult children that lived in different countries could desire greater contact relative to their parents, and thus felt they had a higher contact frequency. This is plausible as it is more common for adult children to move abroad and parents to stay in the home country rather than vice versa. It must be highlighted however that the relationship between distance and contact frequency is not straightforward (Dykstra et al., 2014). Further research is required to understand more fully the relationship between contact frequency and distance.

Difference based on age

ICT Use:

It was found that the use of various ICTs used by adult children to connect with their parents varied with the adult-child's age. The use of landline calls, emails, and letters increased with increasing age of the adult child whereas the use of instant messaging applications, audio-video calls and audio only calls (using Skype/FaceTime) decreased. In the UK, there is a negative correlation between the use of internet with age, which could affect people's use of these ICTs (ONS, 2017). Also, older people are less likely to own a smartphone and might be used to using older technologies such as landlines, emails etc. (Ofcom, 2017). The differences of experience with technologies between different cohorts could have influenced their use of communication technologies to maintain relationship over the distance. These findings are in line with Prensky (2001)'s theory of the digital divide which suggests the older generations are not as tech savvy as the ones that grew up exposed to digital technology. The experiences and attitudes towards technologies between different generations (baby boomers, generation X, generation Y and generation Z) are vastly different (Prensky, 2001; Venkatesh, Morris, Davis, & Davis, 2003; Waycott, Bennett, Kennedy, Dalgarno, & Gray, 2010). This suggest that these differences could arise from a cohort effect in addition to age.

The variation of the use of ICTs for parents of different ages followed the variations found in the adult children reporting although the difference was not statistically significant. Generally, the 'newer' technologies were more likely to be used by parents with younger adult children. The same reasoning as discussed in the above paragraph can be followed to explain this.

Our qualitative findings provide a rationale for the preference of some technologies over others. Adult children mentioned their choice of technology to connect to their parents depended on their parent's use of technology. Some adult children wished to use certain media such as instant messengers, Skype, FaceTime, however, they complained their parents were not as tech savvy and that hindered their ability to maintain connected with them. Tee et al. (2009)'s qualitative analysis also found a link between parent's 'tech savviness' and technology choice. In our qualitative findings, adult children also suggested that they would like to use applications that are more reliable and cost less or are free. These findings suggest cost, reliability and simplicity are some of the main points to consider while designing technologies for long distance relationships.

Frequency of contact:
The frequency of contact between adult children and parent decreased with increase in adult children's age. Several other studies have found negative association between frequency of contact and age of adult-child (Birditt, Miller, Fingerman, & Lefkowitz, 2009; Grundy & Shelton, 2001; Kafková, 2017). However, some of these studies refers to face to face contact and some refer to both face to face as well as ICT contact. A possible reason for this negative association between age and contact frequency could be that middle aged or older adults may be less invested in the parent-child tie than young adult children because they're more likely to have formed their own families and experience multiple role demands (Birditt et al., 2009).

Number of technologies used in parent-adult child relationship:
In our research, we propose designing new technologies to support connectedness that could be used in addition to the technologies dyads already use to maintain relationships. This additional media would increase the total number of technologies used by adult children and their parents to maintain contact. Therefore, it was important to examine the number of medias used to connect with mothers and fathers. Also, we assessed if there was any association between the numbers of technologies used to maintain contact (CRS) with connectedness, closeness and relational satisfaction.

We found the adult children used approximately four different technologies to communicate with mother and approximately three with fathers. These figures are slightly higher than reported by Schon (2014) where the CRS reported by young adults with mother was 3.49 (SD= 1.69) and with father was 3.11 (SD= 1.74). Our data suggested that the number of media utilized to maintain parent–adult child relationships is similar to the number utilized in friendship relationships(Van Cleemput, 2010). This is in line with Media multiplexity theory (MMT) which suggests that people in strong tie relationship such as close friend and family use more media for relational maintenance. Relationships with weak ties (e.g. Acquaintances, casual contacts) use "one or at most two media" to connect to one another (Haythornthwaite, 2005b).

The total number of technologies used (CRS) reported by mothers to connect to their adult children was significantly higher than that of fathers. Additionally, these results were significantly higher than those reported by adult children with their respective parents. Intergenerational stake hypothesis states that parents report consistently higher levels of closeness and harmony in the parent child relationship compared to their children (Bengtson & Roberts, 1991). In line with this hypothesis the parent's perceived strength of the tie would be greater than adult children may report. MMT suggests that the greater the strength of the tie, the greater the number of media used, which might explain why parents report higher numbers of media, as they perceive their tie strength higher/stronger than adult children. Parents may have included media which they rarely use, whereas the adult children may have only selected media which they use regularly.

In line with MMT, we found that the CRS reported by adult children with their parents is positively associated with closeness, relational satisfaction and connectedness for both mothers and fathers. Similar to this, we found the CRS reported by mothers with their adult children is positively associated with closeness, relational satisfaction and connectedness. For fathers, only closeness was positively associated with CRS. Schon (2013)'s study examining parents use of ICT to contact young adults indicated that the number of media parents and adult children utilize to maintain their relationship does modestly influence satisfaction. She suggests utilizing additional media can offset a parent's low communication competence (Schon, 2014). These findings suggest that the addition of media could be beneficial in supporting closeness and connected in this relationship.

Comparing the results of adult children survey and parent's survey, we found the contact frequency, closeness, relationship satisfaction and desired connectedness reported by both mother and father was higher than what adult children reported. These results are in line with intergenerational stake hypothesis (Bengtson & Roberts, 1991). This hypothesis posits that parents often feel more positively about relationships with their adult children because they have a greater perceived 'stake' in the relationship. It has been reported by several studies that parents report significantly more frequency of contact, commitment, emotional closeness and overall overstate the positivity of their relationship with their adult children (Trommsdorff & Schwarz, 2007).

In this section we discussed how parents and adult children use ICTs to maintain relationships with each other. We have found significant variations in frequency of contact and ICT usage based on their relationship type, location and age. In line with previous literature, we found that the platforms that are popular are the simplest to use, fast, and inexpensive (Barkhuus, 2007; Faulkner & Culwin, 2004; Hall & Baym, 2012).

4.6.2 Connectedness between parent and adult children

In our research, we propose designing novel technologies to support connectedness in long distance parent-adult child relationships. However, we do not know what value the connectedness has for this relationship and to what extent adult children desire connectedness with their parents and vice versa.

To assess what value connectedness has for this relationship, we explored if it had any association with emotional closeness and relational satisfaction in this relationship. We found strong positive correlations between connectedness and closeness as well as satisfaction for adult children with both mothers and fathers. This is not surprising as a sense of connectedness is engendered by the act of contacting someone as well as a high frequency of contact (Kuwabara et al., 2002; Licoppe, 2004; Rettie, 2003). As found in our study, there is a lot of previous literature suggesting positive association between frequency of contact and closeness and relationship satisfaction (Carstensen, 1992; Lye, 1996; Rossi, 1990). The association is bidirectional meaning higher contact frequency will result into more closeness and higher satisfaction (Carstensen, 1992; Granovetter, 1973; Lye, 1996) and vice versa. We also found strong a positive correlation between desired connectedness and closeness with both mother and fathers. This is also not surprising as adult children that are emotionally closer to their parents may desire higher connectedness with them. Although our data does not enable us to state the direction of the relationship, the strong positive correlations between these variables suggest that designing technologies to support connectedness could be beneficial to support closeness in adult child- parent relationship.

As with adult children, we found a strong positive association between connectedness and closeness as well as satisfaction reported by mothers. Mothers reported frequent contact which is associated with high closeness and satisfaction in the relationship. We also found a strong positive correlation between desired connectedness and closeness reported by mothers suggesting that mothers that are emotionally closer to their adult children desire higher connectedness. For fathers however, we did not find an association between connectedness and closeness or connectedness and satisfaction. It is likely that the lack of correlation for father's variables could be due to inefficient responses as we only had 49 fathers filling in the questionnaire.

To understand whether adult children/parents desired more connectedness with their respective parents/adult children, we measured their desired connectedness and compared it with their actual connectedness. Adult children reported high desired connectedness for both their father and mother. However, their actual connectedness with their mother was significantly higher than their fathers. The adult children reported significantly higher desired connectedness for their fathers than their actual connectedness. The difference between the desired and actual connectedness was trivial for mothers.

Parents' online survey showed, both mothers and fathers reported high desired connectedness with their adult children. However, mothers' desired connectedness was significantly higher than fathers. For both mothers and fathers, the desired connectedness was significantly higher than their actual connectedness with their distant adult children. This suggests that parents desired to be more connected than they already were. This finding is a key indicator that there is a need for designing novel technologies to support connectedness in this relationship. Comparing adult children's data with parent's data, we also found that parents desired connectedness is significantly higher than adult children's desired connectedness. This is in line with our findings of the *SmartLamp* study dissed in Chapter 3. These findings also confirm intergenerational stake hypothesis which posits that parents are more invested in the relationship than their adult children (Bengtson & Kuypers, 1971).

As the feeling of connectedness is facilitated by contact using ICT; the frequency and the nature of contact could have had an effect on their feeling of connectedness (Licoppe, 2004). Adult children have significantly less contact with fathers than mothers (Fingerman et al., 2012; Kaufman & Uhlenberg, 1998; Lye, 1996; Ward et al., 2014). The qualitative data from this study suggested that adult children had only occasional contact with father and it was mainly for instrumental or practical purpose where they talked to mother even if there was no work (just to say hello). Mothers tend to send more affective messages where father tend to have more instrumental contact with adult children which also could have resulted adult children feeling more connectedness with their mother than their father (Ward et al., 2014). Schon (2013) reported mothers maintaining a 'connected mode' with adult children. Other studies report that it is usually the mother in the family that take the kinkeeper role to maintain various activities such as planning family rituals or family reunions (Leach & Braithwaite, 1996). These could be the reasons for adult children's high connectedness with mothers. Adult children reported feeling significantly closer with their mothers than their fathers (see table 16). Dibble et al. (2012) that use same closeness scale as this study, also report high closeness with mothers, rather than with fathers. Adult children also report higher satisfaction and higher quality of relationship with mothers than fathers (Lye, 1996; Schon, 2014).

Another way we explored the difference between desire and actual connectedness is by assessing if the adult children and parents were happy with their contact with their respective parents and adult child. We asked a question to choose how participants felt about their contact with their father/mother/adult child. Results of adult children's survey showed 25% adult children wanted more contact with their mother and 37% wanted more contact with their father. 72% and 62% said they were happy with contact with their mother and father respectively. Results of parents' survey showed 25% of mothers and 49% of fathers wanted more contact with their adult children. 75% of mothers and 51% of fathers said they were happy with their contact

with their adult children. None of the parents wanted less contact with their adult children.

Results of adult children's survey showed 3% adult children wanted less contact with mother and 1% said they wanted less contact with their father. Upon inspection of qualitative data for these participants, it was found that these adult children did not have a good relationship with parents. For example, a son mentioned that he and his siblings were bullied by their father therefore he does not like to see him. Some studies report that relationship problems like basic personality differences and parents providing unsolicited advice tend to cause problems in adult child parent relationship (Birditt et al., 2009). Their study, which investigates tension within parent adult-child relationships, reported that both adult sons and adult daughters reported more tension with their mothers than with their fathers. They suggest this could be because adult children feel their mothers make more demands for closeness or that they are generally more intrusive than fathers. Despite this, a considerably higher percentage of adult children reported wanting more contact with both fathers and mothers. Rubin (2015) report that the need for contact between parents and adult children is expected to grow. The qualitative data of our study was complimentary to these findings for example, some adult children mentioned that they would like more contact with their parents and that they would like to use different types of ICTs with their parents.

Our findings from the adult children and parents survey confirm that both parents and adult children desire connectedness with one another. Parents' desired connectedness is higher than that of adult children which is in line with our findings of the *SmartLamp* study discussed in Chapter 3. To the best of our knowledge this is the first study that has reported the role of connectedness within the parent and adult child relationship.

4.6.3 Parent and adult children's needs and wishes towards each other

In this study, we also explored what adult children miss the most when living away from their parents. Knowing that their parents are okay, and their presence was the main two things people missed. The qualitative data from our study gave insight about the 'presence' needed. Adult children suggested wanting to use technologies that would allow them to see or feel the presence of their parents. For example, many participants mentioned wanting to use Skype/FaceTime with their parent or wanting an easy way to video call or use virtual reality to feel as if they were next to them.

The findings of our qualitative data complimented the findings of our quantitative data, in addition to the findings already mentioned, adult children also missed doing things together with their parents, sharing jokes and banter especially with their father and also missed their mothers' food. Also, adult children reported that their parents can be hesitant to contact them with the concern of disturbing their adult

children in their busy lives. Few also reported that it would be helpful if their parents could know about their availability, so they did not disturb them when they were busy. Cost, reliability, ease of use and appropriateness of the technology were some of the main motiving factors for using a communication technology. These findings are in line with the findings of our *SmartLamp* study discussed in Chapter 3.

Similar to the findings of the adult children survey, parents reported knowing about their adult children's wellbeing and their presence as the two main things they missed the most. However, a considerably higher percentage of mothers reported missing the presence of their distant adult children than fathers did. Adult children reported wanting to share jokes/ banter with their father more than with their mother however mothers reported wanting to share jokes/banter almost four times more than reported by adult children. More fathers reported that they missed talking about daily activities with their adult children whereas, more adult children missed talking about their daily activities with their mothers than fathers. More fathers reported that they miss doing activities together with their adult children than reported by adult children towards their father.

Interestingly, there is a lot of research that suggest providing and receiving practical support as one of the main characteristics of this relationship (Fingerman et al., 2009; Schoeni & Ross, 2005). However, this study suggests, things which are more emotional in nature such as knowing about each other's wellbeing, presence, sharing jokes are what people miss the most when living at a distance. This could be because as found by Rossi (1990) the level of practical or monitory support could remain unchanged when living at a distance whereas things that are effortlessly attained when living at home such as knowing about the person's wellbeing and their presence are greatly missed when living apart. Qualitative data from parent's survey complimented these findings where parents reported that they missed seeing/meeting their adult children in person. They used Skype/FaceTime, Snapchat to fulfil their need of seeing their distant adult-child. A few parents also mentioned that they would like to use virtual reality to feel the presence of their distant adult children. Parent's qualitative data also confirmed the need of reassurance of their adult children's wellbeing.

Parents mentioned wanting to give privacy and not being an intrusion in their adult children's lives. These findings compliment adult children's reports that their parents may feel hesitant to contact them out of fear of disturbing their busy lives. Lewis, West, Roberts, and Noden (2015) in their exploratory study of parents' involvement in the lives of university students reported almost 37% of the "parents who want to be involved but who try to limit involvement and 'hold back'" out of fear of disturbing their adult children in their busy lives at the university. They also reported that adult children recognised the parent's hesitation as parents did not want to make adult children feel obliged to contact them however they wished that parents called

more often. Tee et al. (2009) also suggest that parent's hesitation to contact their adult children to not disturb them might be unfounded.

Keeping each other updated about things happening in their lives was another theme mentioned by parents. Many parents, especially mothers mentioned using family group chat using WhatsApp as a main way to keep most family members updated however they also mentioned sending one to one message about things that were not relevant to others in the chat. As mentioned earlier, mothers' usually take a role of kinkeeper and keep family members informed about one another (Leach & Braithwaite, 1996). Many mothers also mentioned their sons not being very communicative. This could be because men in general tend to view conversations as a means towards a tangible outcomes therefore may not be as communicative as females are (Maltz & Borker, 1982). Also, Tao (2014) suggest that innate qualities of female being more caring and affectionate than males may be the reason for them to be more interactive with parents than males do.

4.7 Limitations and future work:

Although this study has improved on prior studies by exploring the issue from parents as well as adult children's perspectives, it does have limitations. First, that we did not include the same family members to answers both questionnaires. Ideally, we would have liked to have the parents of adult children participants of part one of the study answering the question for part two. However, in order to keep the number of participants high, we employed unrelated adult children and parents. Future studies could conduct studies on dyads from same families to explore how their findings compares to our findings.

Second limitation is that parents' participants from second questionnaire study largely consisted of Caucasian British population. This limits the generalisability because some researchers suggest that non-White individuals typically have more frequent contact with their adult children (Taylor et al., 2006) and also because there are significant differences in technology use in different ethnic background (Padilla-Walker, Nelson, Carroll, & Jensen, 2010). This study also suffers from self-selection bias especially for parents' survey as the participants that use ICT were likely to respond to the survey hence biasing our sample more technologically savvy. We do not have data from population that do not have access to technology therefore the study does not provide understanding of communication between parents and adult children who are not technologically savvy. Third limitation is that the results were obtained from cross-sectional data, so causation cannot be determined. Experiments that manipulate the number of technologies used and connectedness could provide additional insights.

4.8 Conclusion

In this study, we aimed to understand how parents and adult children use ICT to maintain relationships over distance. We looked at the differences in the use of ICT and frequency of contact based on relationship type, living condition (distance) and age. In addition, we explored what value connectedness has for this relationship and whether they desired connectedness with one another. We also explored what they miss or what their needs are while living away from each other.

We found that the platforms that are popular are easy to use, reliable, fast and inexpensive. Dyads used multiple media to connect to one another and the number of medias had a positive correlation with connectedness, closeness and satisfaction. We also discussed that additional form of media could be beneficial for supporting this relationship which gives rational for our research where we propose designing novel technologies to support this relationship.

We found that parents' desired connectedness was significantly higher than their actual connectedness with their adult children. Adult children's desired connectedness was significantly higher for fathers than their actual connectedness with their father. Adult children have high desired connectedness with mothers and also have high actual connectedness with mothers which could be because of stronger relationship with their mothers. We also found that the parents' desired connectedness is significantly higher than adult children's desired connectedness which suggest that parents need for contact might be greater than for adult children. These findings are in-line with our findings from the *SmartLamp* study. Our findings suggest that parent as well as adult children desire more connectedness and contact than they currently have despite of range of different ICT available. We found that his could be because of busy schedules and limited technology use/tech savviness of some parents.

In addition, we found physically distant parents and adult children need reassurance of each other's wellbeing, as well as miss presence of the distant loved ones. Based on these findings, we suggest that a system for connecting parent and adult children that is quick in a way that reduces operational efforts e.g. starting up and unlocking a mobile phone, locating an app, reduces technological challenges e.g. learning to use a new technology, that is lightweight to fit in peoples' busy lives could be beneficial to support connectedness.

Findings of this and the *SmartLamp* study form the basis of our design of next study, by underlining desire to maintain sense of connectedness in busy lives of parents and adult children. In light of these findings, we designed a new system that uses a pair of connected smart jewellery to send 'thinking of you' signals to one another. With the press of a virtual button, participants could send a 'thinking of you' signal to their partner's jewellery, which would then vibrate and flash a small light. This system

was designed as a quick, easy to use and an unobtrusive way of providing reassurance/ ‘peace of mind’ by sending affective messages of ‘thinking of you’. In next chapter, we provide the details of our design and evaluation of this system.

5 Chapter: *ConnectJewellery*- Supporting Connectedness by Providing Vibro-Tactile Feedback via Wearable Jewellery.

This chapter presents a study exploring whether wearable IoT devices can support closeness and connectedness in distant parent-adult children relationships. A longitudinal study was carried out with nine pairs of participants to evaluate two systems, ConnectJewellery and ConnectText, together referred to as Connect systems. ConnectJewellery involves participants receiving 'Thinking of you' messages via smart jewellery in the form of a ring or a bracelet. ConnectText allows the same messages to be received via email or text on a mobile phone. We evaluate, if and how these systems support parent-adult children relationships. We compare ConnectJewellery to ConnectText to understand if communication differs when messages are sent via wearables using vibro-tactile feedback or via mobile phones.

5.1 Introduction

In this study, we continue to explore how novel technologies using IoT may support distant parent-adult child relationships. In Chapter 3 we evaluated an awareness technology called *SmartLamp* with six pairs of parent and adult children. Results revealed that awareness of the distant adult child could enhance the feeling of closeness for parents. We found that both adult children and their parents want to maintain contact. However, adult children may not always wish to communicate with their parents whereas the parents' need for maintaining contact is greater. Although adult children and parents often think about each other, they may not have a particular topic to talk to about and so choose not to initiate contact. Therefore, we decided to design an expressive phatic communication device that would allow an easy way of maintaining contact using wearable smart jewellery and explore if this system could support connectedness in this relationship.

In the second study (see Chapter 4) of this thesis, we conducted an online survey collecting data about the use of ICTs, connectedness and closeness between parents and their adult children. The findings of the survey suggested that adult children, as well as parents, have a greater desire for connectedness than their actual connectedness (i.e. a sense of being in touch) with each other. The study also indicated that the addition of communication technology could enhance connectedness and closeness in this relationship. The findings of our previous studies guided us towards the study reported in this chapter, where we explore a way to convey messages of 'thinking of each other' between parents and adult children to maintain connectedness. Therefore, we present technologies that are designed to maintain a sense of connectedness that could be used in addition to parent-adult children's routine communication as well as potentially being able to bridge the gap between desired connectedness and actual connectedness.

In the *SmartLamp* study (Chapter 3) we argued that connectedness is the most relevant measure for our studies. From the online survey, we found a strong positive correlation between connectedness and the quality of a relationship (closeness and relationship satisfaction), indicating that the addition of communication technology could positively influence connectedness and closeness in the relationship. This suggests that technologies that increase connectedness could be beneficial for parent-adult children relationships.
In the study reported in the present chapter, we designed two ways of supporting connectedness:

i. Via wearable jewellery called '*Connect Jewellery.'*
ii. A virtual button to send "Thinking of you" messages called '*Connect Text.'*

'*Connect Jewellery'* uses the Internet of Things (IoT) enabled jewellery such as rings and bracelets to send subtle messages of "thinking of you" to one another in vibro-tactile format. The second system called '*Connect Text*' sends the same messages in the form of an SMS or an email on mobile phones. The aim is to understand if and how connectedness created via IoT wearables using vibro-tactile sensations compares to messages received via screen-based technology such as mobile phones.

This study uses a mixed method approach to evaluate the systems. Quantitative measures include questionnaires assessing the degree of connectedness and closeness. We also use the Affective Benefits and Costs of Communication Technology (ABCCT) questionnaire, which is a standardised measure designed to quantitatively evaluate communication technologies based on their affective benefits and costs to the relationship (Yarosh, Markopoulos & Abowd, 2014). To collect qualitative data, we periodically asked open-ended questions and conducted interviews at the end of the study. There are two hypotheses:
H1: *Connect* systems will lead to higher level of connectedness than regular contact using traditional ICTs.
H2: *ConnectJewellery* will lead to higher level connectedness and affective benefits than *ConnectText*.

5.2 Background and related work

In this section similar expressive technologies used to express subtle signals such as 'thinking of you' are briefly reviewed. A more detailed discussion can be found in the literature review Chapter 2 (see Section 2.7.2).

As mentioned in the *SmartLamp* chapter (Chapter 3), awareness of someone's presence or contact via ICT with someone can create a sense of connectedness (Kuwabara et al., 2002; Rettie, 2003). Early HCI research in this area included ways of communicating presence in expressive ways, such as Strong and Gaver (1996)'s feather, scent and shaker prototypes which used visual, olfactory and tactile outputs

respectively to convey the presence of a romantic partner over distance. Although these prototypes were never formally evaluated, they opened a design space for researchers and designers to think about novel ways to support interactions which are expressive in nature rather than informative and more emotional rather than instrumental.

To support an intimate connection between romantic partners, Kaye, Levitt, Nevins, Golden, & Schmidt (2005) designed virtual intimate objects (VIO) that use a virtual button on a user's desktop screen. Upon clicking on the button, their partner's equivalent button changes colour to red. Their findings suggested that one-bit information can contribute a surprising amount to a feeling of connectedness. In this case, the sending of a one-bit message was explicitly initiated, and it appears a large part of the perceived value of the tool was the 'thinking of you' implied by the message. As one participant is quoted as saying: "I knew he was still thinking of me when it would go to red."(Kaye, Levitt, Nevins, Golden, & Schmidt, 2005, p. 1530) Their findings were based on a one-week pilot study of this online one-bit communication tool.

As we have already discussed in the literature review in Chapter 2, the work by Bales et al. (2011) that created a mobile app to send awareness information based on the location between romantic couples was successfully able to convey connectedness and peace of mind of a distant loved one. Although the concept of connectedness is not clearly defined by authors, it does provide evidence that vibro-tactile technologies could elicit positive feelings of connection and happiness between distant loved ones.

A number of other devices have been designed that use expressivity strategy (Chang et al., 2002; Chen et al., 2006) (see Appendix A all reviewed devices). However, little or no evaluation has been carried out into the proposed affective benefits of these prototypes and to our knowledge there are no studies that focus on exploring how expressive message exchanged between parents and their adult children could support connectedness. We can speculate that the subsequent appropriation of messaging technology for phatic communication as described by Licoppe and Smoreda (2005) and Taylor and Harper (2003) enabled by the pervasiveness of the mobile phone, is a reasonable way of achieving a similar sense of connectedness. In all the prototypes mentioned so far, the messages were phatic messages. While the message content is indicative, the act of sending the message is explicit. One effect of explicitly initiated communication is a felt expectation and obligation to reciprocate (Kaye, 2006; Taylor & Harper, 2003), which can be viewed as a cost against the affective benefits of the communication (IJsselsteijn et al., 2009). Interestingly, the effort of explicitly sending a message can be viewed as a benefit of the communication (IJsselsteijn et al., 2009; Kelly, Gooch, Patil, & Watts, 2016). Indeed text messages are seen as digital gifts by many people (Kwon et al., 2017).

5.2.1 Digital jewellery to support connectedness

Personal objects such as a watch or a piece of jewellery can be of a tremendous emotional significance and can offer comfort, elicitation of memories and also a sense of self and a sense of belonging for many people (Versteeg, van den Hoven, & Hummels, 2016; Wallace, Dearden, & Fisher, 2007; Wallace, Thieme, Wood, Schofield, & Olivier, 2012). The significance of such kinds of artefacts has also created interest in digital jewellery, and there has been growing interest in the designs of wearable digital jewellery in the HCI community over the past few years, e.g., see (Versteeg et al., 2016; Wallace, 2007). Several researchers have also used ring shaped objects as implementation methods to their systems which are designed as input devices or interaction devices with surroundings e.g., (See Ashbrook, Baudisch, & White, 2011; Jing, Cheng, Zhou, Wang, & Huang, 2013; Nanayakkara, Shilkrot, Yeo, & Maes, 2013). Yet, jewellery has been surprisingly understudied in exploring how it could be used to connect physically distant loved ones. In the review of almost 200 artefacts from HCI and CSCW (see Appendix A), we found only four mentions that referred to digital jewellery specifically to connect people over distance, most of which were either abstract papers or non-published work (Hayashi, Agamanolis, & Karau, 2008; Miner, Chan, & Campbell, 2001; Pradana, Cheok, Inami, Tewell, & Choi, 2014; Silina & Haddadi, 2015a).

One of the early mentions of digital jewellery were paired finger rings, which could send a signal using coloured lights embedded in the rings (Miner, Chan, & Campbell, 2001). However, the authors only mention design ideas on how digital jewellery could be designed and what might be their applications, e.g., reading emails and interpersonal, affective communication. The authors mention designing early prototypes however no details are presented about what they were intended for, how the prototypes were designed and how they functioned. Also, there is no mention of any user studies.

Another reference to a ring is made by Hayashi et al. (2008) who designed a device called *Mutsugoto* (Pillow talk) which is an artefact intended to be used in a bedroom and it allows romantic partners to intimately communicate by drawing on their own bodies. The focus of the design is not on rings, and rings were merely used as a pointer for sensors to track the movement of the figure to project the strokes on the body of the user's distant partner. Also, the focus on this work was on the design of the artefact, and no user evaluation was found.

A *BuddyBeads* project was developed to explore alternative forms of connection between teenage girls. The study proposed a design of a bracelet that allowed non-verbal communication in group members in codes and signals. The authors propose an idea that a group of teenage girls who are friends will have matching smart bracelets made up of beads and a girl can send other group members non-verbal signals, e.g., "cool guy in sight" (Kikin-Gil, 2006, p. 375). The authors present an early stage prototype. The authors conducted a pilot interview study with four girls to

explore if they would like to use such devices. An important finding of these interviews was a mention of "*Squillo",* a term for a practice used in Italy where people ring another person's mobile phone once to say 'hello' or to indicate they are thinking of them. This finding shows the appropriateness of technology for the use of phatic communication to maintain connectedness between loved ones.

Recent unpublished work in this area is by Silina and Haddadi (2015a) work that explores a jewellery-like design of an artefact which remotely shares a person's heart rate to a display on their distant partner's necklace. It is an asymmetrical system where the *sharers* heartbeats are sent to the *wearer's* necklace using a short sequence of vibrations. This is done automatically whenever the *sharers* device detects heartbeat unless he/she turns off the device. Authors conducted a day-long user study that lasted for six hours with six romantic couples. Descriptive data reveals eight out of 12 participants suggested they felt closer to their partner indicating the possibility of connected jewellery to support closeness. Also, four couples suggested they would like to use such technologies suggesting interest in digital jewellery. There were a few issues with the design of this artefact as some users mentioned it being heavy to wear and the *wearers* mentioned that they would have liked to reciprocate which the design did not allow.

A *RingU* project was developed by Pradana et al. (2014) which explored ring-shaped wearable objects to emotionally prime the text messages received via mobile phones. *RingU* were a pair of rings that could be squeezed to send the signals to the partner's ring. Upon receiving the signals, the partner's ring vibrated and changed the colour of the ring to convey emotions sent by the sender. The aim was to explore the use of digital rings to accompany text messages to exchange emotional information of joy, surprise, anger, disgust, acceptance, anticipation and neutral feelings. Therefore, if the content of text message was positive, neutral or negative, the ring would project that using colour and vibro-tactile feedback. The researchers carried out in the lab experiment with 20 participants that took 10- 15 minutes. Participants were asked to use *RingU* prototypes for a few minutes, and they were asked to rate messages, colour and vibration. Their findings suggested that touch and colour stimuli were effective in evoking and changing the emotional perception of a text message. There were, however, multiple issues with their study. First, their device looked gadget-like and had to be connected to the computer as well as a box that contained an Arduino kit using wires. Secondly, the study was carried out in the lab with single participants to understand the effectiveness of perceived emotions of texts and no evaluations with dyads were carried out, therefore, their effectiveness to support relationships is unknown. Yet, authors make claims that these rings send virtual hugs or "squeeze" to partners and that the receiver of signals felt the warm presence of their partner by seeing the light. Their study does, however, show the possibility of these types of artefacts to evoke an emotional response in users using vibro-tactile sensations and lights.

Digital jewellery can also be called computational jewellery or smart jewellery which refers to artefacts that act as jewellery as well as a computational device. They have recently been becoming popular, especially with wearable technologies, however, have also received criticism for their designs being gadget like and unfashionable (Silina & Haddadi, 2015b). There have been several jewellery-like devices available on the market, and there have been multiple Kickstarter projects seeking to design these types systems to connect loved ones, e.g., (TacTilu, 2013; theTouch, 2016). However, these systems are yet to be truly commercialised. Also, in our knowledge, there has been little to no research conducted to explore user's experiences with them.

The review of literature discussed in this chapter suggest the scarcity of research on how digital jewellery could support connectedness in a close interpersonal relationship. There are no studies on parent-adult children relationship. Previous studies also do not carry out thorough evaluations. These studies do not measure connectedness or closeness neither do they employ mixed method approach using qualitative and quantitative data gathering techniques and very few record data about the system interaction. The findings of these studies do however guide us towards the possibility of supporting connectedness using vibro-tactile feedback using jewellery. The literature shows the value of sending other phatic messages (e.g. *on-off* and *symbols* discussed in Chapter 2 Section 2.7.2) or subtle messages of 'thinking of you' however, little has been done to explore this interaction paradigm to support connectedness - oriented communication (Kuwabara et al., 2002). We will now present an exploration in the wild of a paired set of wearable jewellery that allows vibro-tactile feedback to send 'thinking of you' messages between parents and adult children. We compare these to the messages sent by traditional ICT such as SMS or Emails.

5.3 Aim and research questions

The purpose of the study is to explore the effectiveness of two technological systems '*Connect Jewellery' and 'Connect Text'* in parent-adult child relationships where the parent and adult child live separately. The study quantitatively measured connectedness, closeness and ABCCT score as well as qualitatively assessing the experiences of participants using these systems.

The *ConnectJewellery* consists of either a ring or a bracelet that was worn by all participants for the duration of the study. This jewellery was connected to a virtual button on their study partner's mobile phone and vice versa. Pressing the button results in signalling the study partner's jewellery. *ConnectText* works in a similar way to *ConnectJewellery.* However, pressing the virtual button resulted in sending "thinking of you" text messages to the mobile phone of the study partner instead of signalling the jewellery. It is worth noting that in the initial design of *ConnectJewellery,* the button was on the jewellery so that the user would not need

their phone to send signals. However, to our knowledge there was no 'off the shelf' smart jewellery with a button at the time of the data collection hence modification to the design was made to allow another realistic way to send signals to jewellery.

The study aimed to evaluate *ConnectJewellery* and *ConnectText* as well as the routine communications of the participants. The study specifically aimed to gain insight into whether signals sent via wearable haptic device could foster connectedness in distant parent-adult children. Below are the research questions that this study aimed to explore.

5.3.1 Research questions

RQ 1: Does the *ConnectJewellery* and the *ConnectText* systems affect feelings of connectedness and closeness?
This was observed by comparing connectedness and closeness scores taken before the study, for the duration of the use of *ConnectJewellery* and *ConnectText* systems and after the use of both the systems. This research questions attempts to answer the overall thesis research question (RQ1a and RQ2b) presented at the end of the literature review (see Chapter 2 Section 2.10).

RQ 2: Is there a difference between the affective benefit and costs of *ConnectJewellery* and *ConnectText*?
This was observed by comparing scores of ABCCT questionnaire on affective benefits and costs of jewellery and text-only system. These research questions attempt to answer the overall thesis research question (RQ1) presented at the end of the literature review (see Chapter 2 Section 2.10).

RQ 3: How do parent-adult children maintain contact and how does the *Connect* systems integrate into that experience?
This was explored using qualitative data from interviews conducted with all participants at the end of the study as well as open-ended questions from periodically collected questionnaires. These research questions attempt to answer the overall thesis research question (RQ1c) presented at the end of the literature review (see Chapter 2 Section 2.10).

5.4 Method

5.4.1 Participants

Participants were recruited by word of mouth advertising as well as advertisements on social media, e.g., Facebook and Twitter. The advertisement poster is included in Appendix D. Nine pairs of participants took part in the study. Out of nine pairs, seven were mother-daughter pairs, and two were mother-son. The adult children's age ranged between 22 to 42 years (M= 28, SD= 7.98) and the parents' age ranged between 45 till 68 (M=55, SD= 8.76) years old. One pair lived in the same city but

different houses, four pairs lived in the UK, but in different cities, two pairs lived in different countries. The remaining two pairs had both adult children travelling to different countries as well as in the UK during the study, but their parents stayed in the UK during the study. A prize draw was conducted at the end of the study, and two participants received a piece of smart jewellery for taking part in the study.

5.4.2 Measures

A mixed method approach was used to collect quantitative and qualitative data. Data were collected pre, during and post-study from all participants. The pre-study questionnaire included demographic questions such as age, distance from the study partner (whether they live in the same city but different houses, live in different cities but same country or live in different countries), the technologies they use to contact each other, their communication frequency, closeness, relationship satisfaction, and actual connectedness to the study partner. All pre, during and post-study questionnaires are included in Appendix D. We also collected data on the system usage from the system itself.

Closeness:

The inclusion of others in the self (IOS) scale was used in this study to measure closeness in the relationship (Aron et al., 1992). This is the same scale used in the *SmartLamp* study reported in Chapter 3. This is a graphical Likert scale, which has seven graphical images consisting of 2 circles, one representing the self and the other representing the study partner (see Figure 22). The periodically sent questionnaire included a question asking participants to choose the image that best described their relationship. The end where circles are completely separate represents not at all close, and the other end where the circles are almost overlapping represents extremely close. The options represent various degrees to which participant feel close to their study partner. The score is between 1 to 7 where one accounts for minimum closeness and seven accounts for maximum closeness.

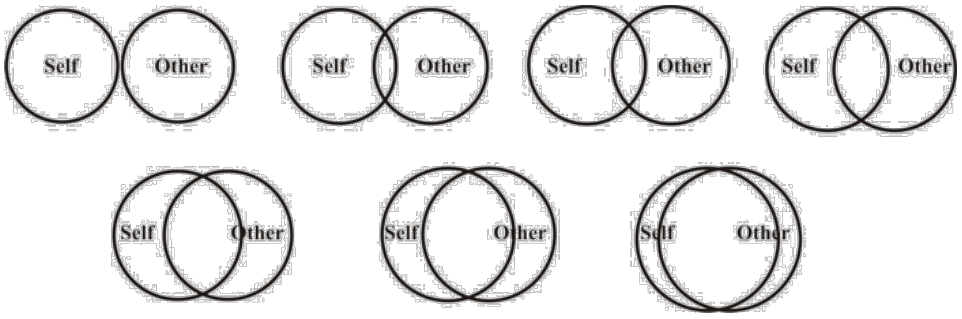


Figure 22. Inclusion of the others in the self (IOS) scale (Aron et al., 1992).

The reason for using this closeness measure is it is validated and takes less time to fill in compared to other validated closeness measures such as URCS, RCI (Berscheid et al., 2004; Dibble et al., 2012). As we asked our participants to fill it in

twice a week along with other measures, it was deemed the most realistic to complete every week.

Connectedness:
The Connectedness Scale was reported in work by Schon (2013). She mentioned that it is developed based on the definition of connectedness given by Rettie (2003) and Licoppe (2004). The details and rationale for using the scale were discussed in the Chapter 4 (see Section 4.4.4). The scale has excellent reliability, $\alpha = .92$ for fathers, $\alpha = .93$ for mothers and $\alpha = .95$ for adult children. The scale consists of eight items that are rated on a 7-point Likert scale: 1= "Strongly disagree" to 7= "Strongly agree". Sample items include "My father calls and/or messages throughout the day mainly just to exchange pleasantries (hello's, goodbyes)." and "My father calls and/or messages throughout the day just to maintain contact." Responses of 8-items were summed and averaged to create an index of actual connectedness.

Affective Benefits and Costs of Communication Technology (ABCCT):
Based on the previous research discussed in the literature review (see Chapter 2) as well as the findings of the *SmartLamp* study (see Chapter 3), we anticipated that there would be some benefits and some costs of using *Connect* systems. To assess them quantitatively we employed the Affective Benefits and Costs of Communication Technology (ABCCT) questionnaire that quantitatively evaluates communication technologies based on several benefits and costs (Yarosh et al., 2014). This questionnaire was developed by researchers working in the area of computer-supported cooperative work (CSCW) in an effort to quantitatively measure the effectiveness of communication technologies and focuses on "a specific technology in question rather than connectedness or relationship quality in general" (Yarosh et al., 2014, p. 84).

To our knowledge, the ABCCT questionnaire is the only reliable and validated questionnaire in the area of HCI and CSCW that focuses on examining the emotional benefits and costs of a given social communication medium and takes less than 10 minutes to complete. The authors claim that the questionnaire is sensitive enough to show differences between two communication systems. It is designed to evaluate the difference between communication technologies with respect to four benefits: Emotional Expressiveness, Engagement and Playfulness, Presence in Absence, Opportunity for Social Support, and three costs: Unmet Expectations, Unwanted Obligations, and Threat to Privacy. There are total 26 items that are rated on a 5-point Likert-type frequency scale (never, rarely, sometimes, usually, or always). The authors of ABCCT describe low, mid and high ranges of the score (Yarosh et al., 2014). If a participant averaged between 1.00 and 2.33 on a particular scale, he or she was classified as "low" on that scale; between 2.34 and 3.66 was classified as "medium" on that scale, and between 3.67 and 5.00 was classified as "high" on that scale.

Emotional expressiveness: This refers to the ability of communication technology to express one's own being as well as being able to perceive the feelings expressed by the other. A sample item consists of- "Communicating with <Study partner> using <Technology> helps me tell how <Study partner> is feeling that day."

Engagement and playfulness: This refer to the ability of communication technology to allow for engaging communication between partners as well as if the communication via medium is fun and exciting. A sample item consists- "I have fun with <Study partner> while using <Technology>."

Presence-In-Absence: This is defined as "subjective sense of social others while separated from them by time or space" (Howard et al., 2006, p. 909). This item collectively measures connectedness and closeness. A sample item consists of- "Communicating with <Study partner> using <Technology> helps me feel closer/more connected to <Study partner>."

Opportunity for Social Support: This refers to the ability to provide social or emotional support without physically being there. This refers to the general sense of someone being available for you which may engender a feeling of being loved and reduce negative feeling, e.g. sooth anxiety. A sample item consists of- "Communicating with <Study partner> using <Technology> when I am having a bad day helps me feel better."

Unwanted Obligations: It has been found that communication technologies may introduce an unwanted obligation to keep in touch. A person might feel guilty not maintaining adequate communication as much as the other's expectations. A sample item consists of- "I feel guilty if I don't answer a contact <Study partner> makes using <Technology>."

Unmet Expectations: It has been found that communication technologies may increase expectation for communication which is consisted as a cost of using a system. Some expectations could be returning missed contacts, how frequently a person contacts or replies to messages. A person could feel unloved for frustrated if these expectations are not met. A sample item consists of- "I feel sad when <Study partner> takes too long to respond when I try to contact <Study partner> using <Technology>."

Threat to Privacy: This refers to three major aspects of privacy threat introduced by communication technology, a person seeing or hearing something about you that you want to keep secret, other people in the environment overhearing your conversation or concerns that you might be invading others privacy. A sample item consists of- "I worry that others may overhear or see something that <Study partner> and I share using <Technology>"

The ABCCT questionnaire covers a range of emotional factors, and has been notably used in related work (Forghani, Venolia, & Inkpen, 2014; McGill, Williamson, & Brewster, 2016). Participants were asked to fill in this questionnaire at the end of the *Connect jewellery* and *Connect Text* phases. The questionnaire is available in the Appendix D.

Qualitative data:
There were two main sources of qualitative data: the free-text component of a questionnaire where participants were asked to write their thoughts twice a week and the semi-structured interviews at the end of the study.

The open form questions were included in the same questionnaire that collected quantitative data about the connectedness and closeness. This questionnaire was sent twice a week and asked participants to elaborate on their communication and general contact during the study. Participants were prompted with the following points,

- Compared with the "normal" amount of time you usually spend communicating with your study partner, how typical were the past few days?
- If this was not typical for you, please can you briefly explain why?
- Please tell us how you felt about your contact with your study partner over the past few days? How did your contact make you feel about your relationship? Please write any thoughts you may have about your contact with your study partner or the study.

A semi-structured interview was conducted with all participants at the end of the study which asked questions about the general communication between the pairs and questions on how they used *ConnectJewellery* and *ConnectText.* Some prompts included the use of technology, design features and feelings evoked. The semi-structured interview questions are included in Appendix D. We decided to opt for semi-structured interviews because they allow researchers to be prepared to ask questions about the relevant topics that were the focus of investigation as well as allowing freedom for participants to express their views in their own terms(Braun et al., 2014; Cohen & Crabtree, 2006). Another benefit of semi-structured interviews is that they guide the investigation yet provide opportunity for identifying new ways of understanding the topic at hand (Cohen & Crabtree, 2006).

The interviews took approximately 30 minutes each and were conducted in the phase four of the study, after they had used both the *Connect* systems. All dyads were interviewed separately as we did not want to bias their answers because of the presence of their adult child or parent. All interviews were audio recorded using a mobile audio recorder. They were immediately saved on the university drive, and audio recordings from the mobile device were destroyed. They were all audio recorded and transcribed by the primary researcher. Thematic analysis was carried

out on the transcripts by following six phases described in Braun et al. (2014) the details of which are discussed in Chapter 3 (see Section 3.4.2.)

All the quotes from questionnaires that were sent twice a week were also used along with interview transcripts to analyse the data. The commercial software NVivo 11 was used to manage the qualitative data. All transcriptions were anonymised. Names of the participants were replaced by dummy names to maintain anonymity of the participants.

System use data:
The system use data was collected by each time logging when participants pressed the virtual button on their phone. The system was set in such a way that when a participant pressed the button, it sent an email/text message on another participants' phone. The detailed design of the device is explained in the section below. These emails were then logged manually in an excel sheet by the primary researcher to calculate the total number of messages sent by all participants in the *ConnectJewellery* phase, *ConnectText* phase and after they were asked to stop using the system.

5.4.3 Design of the device

The *Connect* systems were intended to provide an additional communication/signalling channel to create a subtle connection between parents and their adult children. Following is the description of how the system works,

Connect Jewellery
The *Connect jewellery* consists of either a ring or bracelet (see Figure 23) which was given to all participants. We used off the shelf smart jewellery called Ringly[4] and the Flic[5] app which provides programmable virtual buttons on the phone. The Ringly jewellery connected to the smartphone via Bluetooth and allowed customised notification alerts through vibration and subtle colour-coded lights. It was originally designed for notification of important messages/emails received on the mobile phones however, for this study, we appropriated the use of the Ringly to connect two distant people.

Both participants were asked to install Flic and Ringly app on their mobile phones. Using the Flic app, we created a small virtual button on a participants' mobile screen. Participants could customise their virtual button to different colours or icons (see Figure 24). The virtual button was connected to their study partner's jewellery and vice a versa. Pressing of the virtual buttons on their mobile screen resulted in signalling their study partner's jewellery. The received signals made the

[4] https://ringly.com/
[5] https://flic.io/

ring/bracelet vibrate and a small light flashed. All participants were asked to press the virtual button on their phone when they thought of the other to send signals to their partner's jewellery. They were given freedom to press only if they felt like sending the signals and were told that they were under no obligation to use the system as we wanted the interaction to be as natural as possible.

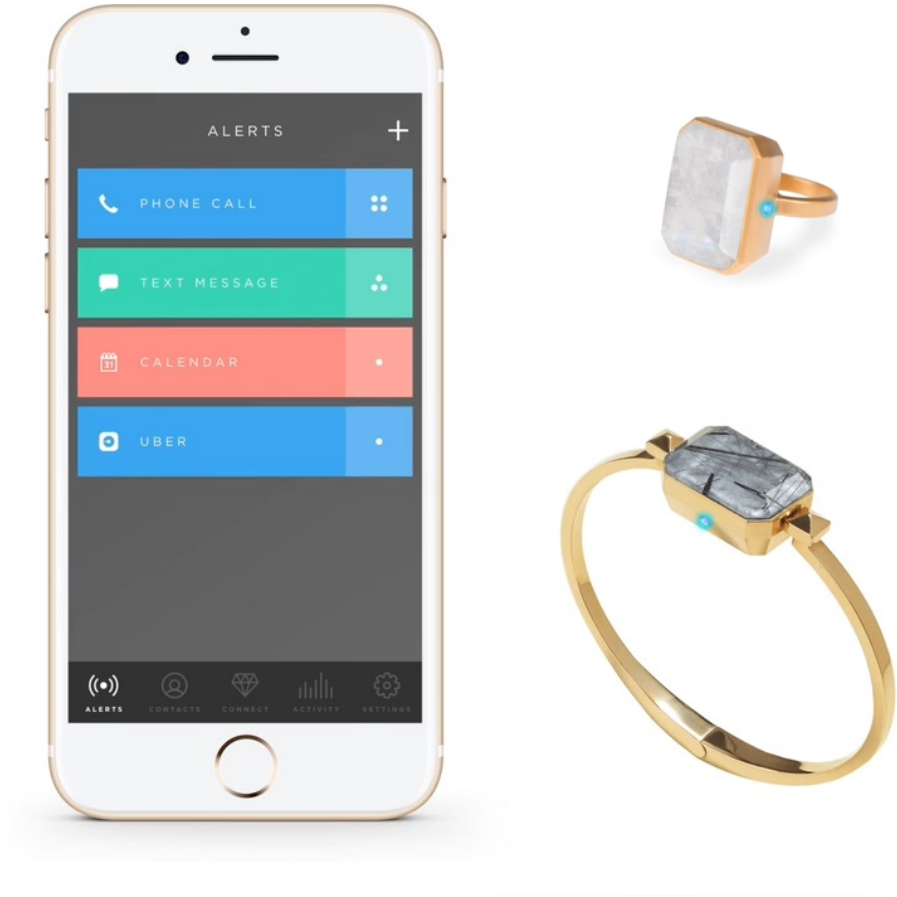


Figure 23. A screenshot of the Ringly app with a bracelet and a ring.

Connect Text

The *Connect Text* worked in a similar way to the *Connect Jewellery*. The difference was that instead of sending signals to the jewellery of the study partner, the signal was sent as text on their mobile phone and vice versa. When a participant pressed the virtual button on their mobile phone, an SMS/Email was sent to their study partners' mobile phone saying, "Just thought of you so pressed the button". The setup involved setting up a 'Flic' app on all the participants mobile phones.

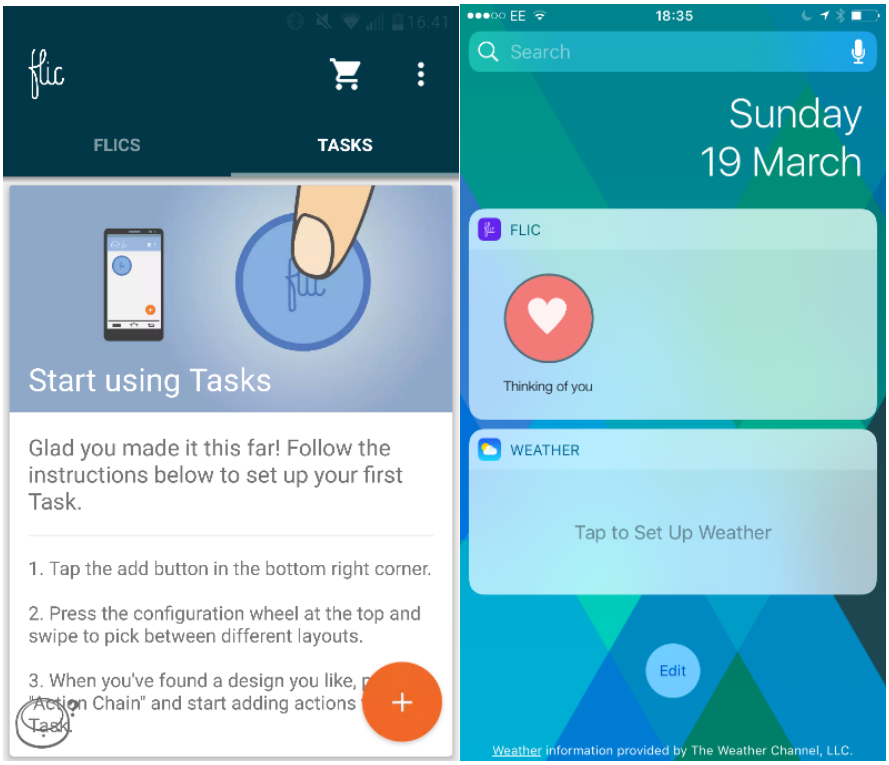


Figure 24. A screenshot of the Flic app and 'Thinking of you' button on the main screen of a mobile phone

5.4.4 Ethics

Approval was granted by the University of Bath, Department of Psychology Ethics Committee, Ref: 16-261. Included in the Appendix D are the ethics application and consent forms used.

5.4.5 Design and procedure

A longitudinal study was carried out 'in the wild' with nine pairs of parents and adult children. We asked participants to choose one of their parents or adult children that they would be happy to take part in the study with. Participants were asked to undergo their normal daily activities whilst undertaking the study. The deployment of *Connect system* in the real world rather than in a laboratory setting was expected to enable more naturalistic data collection.

Before the beginning the study, participants were sent the information sheet via email and were asked to consult with parent/adult children that they would like to participate with and if they were happy to participate then the contact information of the partner was obtained. From then on, all participants were contacted separately for the duration of the study. They were all separately sent the information sheet via email and completed a consent form sent by post or signed in person. They were then sent a pre-study questionnaire asking about their demographics e.g., age, occupation, distance from the study partner, the technologies they use to contact each other, their communication frequency, connectedness, closeness and relationship satisfaction

with the study partner. The information sheet, consent form and pre-study questionnaire is added in Appendix D (see Section 11.2, 11.3, and 11.4).

Participants were given the jewellery in person or it was sent by post along with a pre-paid return package. The primary researcher guided all participants to set up the system either in person, by telephone or via Skype a few days before the study. The system was tested by sending a couple of test 'Thinking of you' messages, however they were asked not to use the system until further instructed.

The main study was for six weeks and was divided into four main phases. Four randomly selected pairs were assigned to do *ConnectJewellery* for phase two and *ConnectText* for phase three and the other five were given *ConnectText* for phase two and *ConnectJewellery* for phase three to avoid order effects.

- **Phase 1 (Week 1)** consisted of the participants completing questionnaires that collected quantitative and qualitative data about their communication, connectedness and closeness felt before using the *Connect* systems. The questionnaire took less than five minutes to complete and was sent twice a week as a link as an online questionnaire via email. The questionnaire is included in Appendix D (see Section 11.5).
- **Phase 2 (Week 2-3)** consisted of both participants using either of the *Connect* systems ('*Connect Jewellery'* or '*Connect Text*'). All participants were asked to press the virtual button on their phone when they thought of the other to send signals to the other's jewellery or mobile phone. They were given freedom to press only if they felt like sending the signals and were told that they were under no obligation to use the system as we wanted the interaction to be as natural as possible. The participants used the system for two weeks and were asked to fill in the same questionnaire as the week before. An email was sent twice a week to collect quantitative and qualitative data about their connectedness, closeness and feeling about the contact they had since they last filled in the questionnaire. At the end of this phase they were asked to fill in the ABCCT questionnaire for that particular system. They were informed that the second phase was over and were asked to begin the phase three of the study.
- **Phase 3 (Week 3-4)** consisted of using the other *Connect* system (e.g. if they used *ConnectJewellery* in the first phase, they stopped using that and instead used the *ConnectText* in this phase). Twice a week they were asked to fill in the same two-minute questionnaire sent as a link via email. At the end of this phase they were asked again to fill in the ABCCT questionnaire for that particular system.
- **Phase 4 (Week 5)** consisted of informing participants that the testing phase of *Connect* systems had come to an end. They were asked to return the Ringly jewellery. However, they were not asked to uninstall apps as we were

interested to see if they continued to use the system after the study. Participants were individually invited to attend an interview either in person, telephone or via Skype. All interviews were conducted within seven days after they were asked to stop using the *Connect* systems. This phase also involved completing a questionnaire sent approximately a week after they finished using *Connect* systems to collect data about connectedness, closeness and feeling about their contact after they stopped using the *Connect* system.

We had four Ringly jewellery pieces; two rings and two bracelets in separate sizes. Depending on the ring or wrist size of the participant, they were given appropriate jewellery and therefore we could run a study at the most with two pairs of participants at a time. The total data collection for the study was conducted over an eight-month period.

5.5 Results

5.5.1 Descriptive data

This section presents descriptive data about connectedness and closeness reported by parents and adult children. The results for individual research questions are presented in section 5.5.3. The quantitative data was analysed using SPSS software. Table 12 shows the mean connectedness and closeness scores for parent and adult children for the pre-study, jewellery phase, text-only phase and post-study conditions. Figure 25 shows the averaged connectedness and closeness scores of parents and adult children for all four phases.

Table 14

Descriptive statistics split by phases: pre-study (n=36), jewellery phase (n=72), text-only (n=65) phase and post-study phase (n=19)

	Pre-Study *M* (*SD*)	Jewellery *M* (*SD*)	Text Only *M* (*SD*)	Post-Study *M* (*SD*)
Connectedness				
Adult children	4.06 (1.08)	5.28 (.93)	4.80 (.71)	4.33 (.93)
Parent	3.80 (.76)	5.71 (.85)	4.74 (.86)	4.91 (1.27)
Closeness				
Adult children	4.55 (1.16)	5.30 (1.00)	4.90 (.83)	4.22 (1.09)
Parent	5.22 (.90)	5.80 (.93)	5.54 (1.11)	4.89 (1.53)

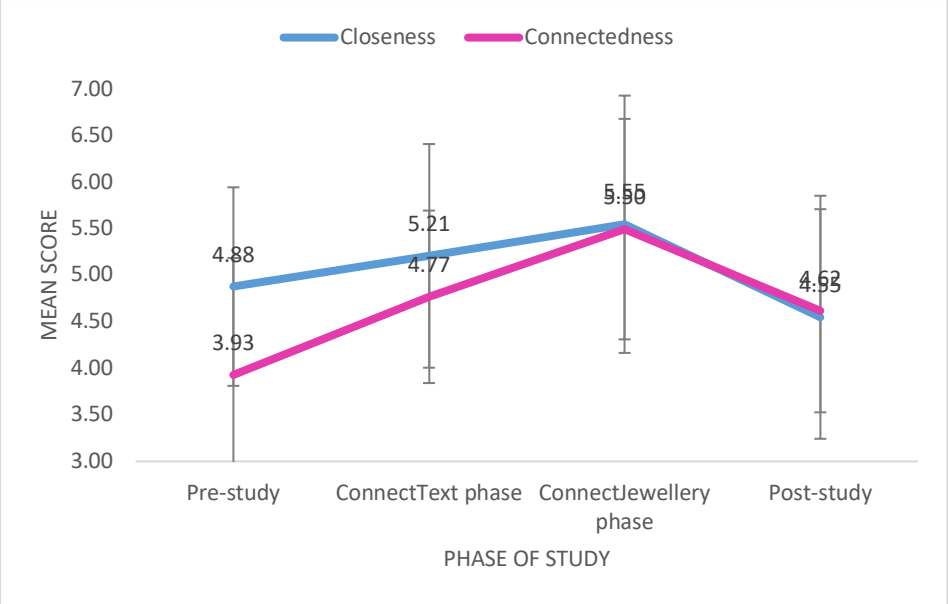


Figure 25. Graph of the averaged scores of parents and adult children over four phases.

5.5.2 Interaction data

Raw interaction data showed sporadic message exchanges during the use of both of the *Connect* systems by dyads. The number of messages sent varied a lot depending on the individual; ranging from 0 to 64 in one day. Interaction data showed that 15 participants out of 18 continued to use *ConnectText* for several days even after the study was finished. One mother continued to send the signals for almost four months after the study was concluded although she did it less frequently after the first few weeks.

On average participants sent around 4 messages per day during the *ConnectJewellery* phase and two messages per day during *ConnectText* phase. The participants that continued using *ConnectText* after the study sent average of 1.5 messages per day on the week following the study. Figure 26 shows an example of interaction data generated by the system for the pair number five. Remaining graphs presenting interaction for all the other pairs are included in Appendix D (see Section 11.10).

In the interviews, participants mentioned various different factors that affected their daily exchange of messages, for example a pair sent as many messages as possible over the last couple of days of the *ConnectJewellery* phase as they wanted to make the most out it. Some participants did not wear a jewellery on days it was raining. Therefore, they missed all the signals received and also sent less signal on that day.

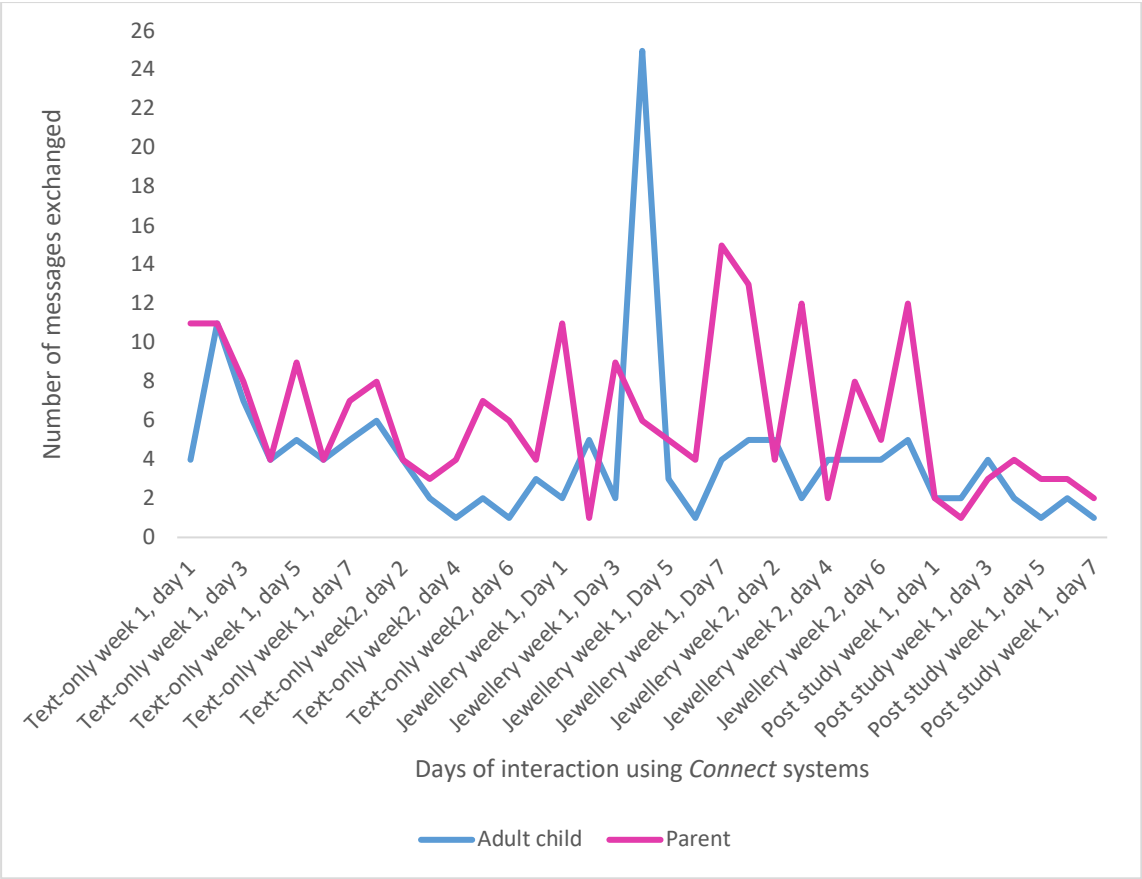


Figure 26. Number of messages exchanged using *Connect* systems between pair number five.

RQ 1: Does use of the *ConnectJewellery* and the *ConnectText system* affect feelings of connectedness and closeness?

This was observed by comparing connectedness and closeness scores taken prior to the study, for the duration of the use of *ConnectJewellery and ConnectText* and scores after the use of the systems.

Connectedness:

A one-way repeated measures ANOVA was conducted to compare ratings of connectedness before, during the jewellery phase, during the text-only phase and after the study. There were no outliers and the data was normally distributed at each time point, as assessed by boxplot and Shapiro-Wilk test ($p > .05$), respectively. The assumption of sphericity was not met, as assessed by Mauchly's test of sphericity, $\chi 2$ (5) = 11.868, $p = .037$. Epsilon (ε) was 0.743, as calculated according to Greenhouse & Geisser (1959) and was used to correct the one-way repeated measures ANOVA. The connectedness differed significantly between the phases, F (2.229, 37.892) = 15.515, p <.001, partial $\eta 2 = .47$.

A post-hoc Bonferroni comparison indicated that pairwise difference was significant between the pre-study connectedness ($M = 3.93$, $SD = .92$) to *ConnectJewellery* ($M =$

5.50, *SD* = .89) and *ConnectText* (*M* = 4.77, *SD* = 0.763) phase $p < .001$. Also, a pairwise difference was significant between *ConnectJewellery* to *ConnectText* and post-study phase (*M* = 4.62, *SD* = 1.12), $p < .001$. The difference was non-significant for *ConnectText* to post-study phase. Suggesting that using *ConnectJewellery* systems did significantly increase feelings of connectedness compared to all other phases. Using the *ConnectText* system significantly increased the connectedness compared to the pre-study but not compared to the post study phase.

Closeness:

A one-way repeated measures ANOVA was conducted to compare the closeness ratings before, during *ConnectJewellery* phase, during *ConnectText* phase and after the study. There were four different outliers, however, it was decided that the outliers would not be omitted, as they were not extreme. The data was normally distributed at each time point, as assessed by boxplot and Shapiro-Wilk test ($p > .05$), respectively. Mauchly's test of sphericity indicated that the assumption of sphericity had not been violated, $\chi 2$ (5) = 8.298, $p = .141$. The result of the test revealed a statistically significant difference in closeness ratings across phases F (3, 51) = 4.152, $p = .01$, partial $\eta 2 = .196$.

A post hoc Bonferroni comparison indicated that the closeness reported during *ConnectJewellery* (*M* = 5.55, *SD* = .97) was significantly higher compared to pre-study (*M* = 4.88, *SD* = 1.06), $p = .03$. All other pairwise comparisons were non-significant. The results suggest that using *ConnectJewellery* increased feelings of closeness for parents and adult children compared to closeness felt after the study.

A Spearman's rank-order correlation was run to determine the relationship between closeness and connectedness. There was a strong, positive correlation between closeness and connectedness, which was statistically significant ($r_s = .592$, $p < .01$). This is similar to the result of online survey from chapter 4 ($r_s = .588$ for fathers, $r_s = .554$ for mothers, $p < .01$ for both.)

RQ 2: Is there a difference between the affective benefit and costs of *Connect jewellery* and *Connect Text*?

This was observed by comparing scores of the ABCCT questionnaire on affective benefits and costs of the jewellery and text only system.

We compared the scores using 2-tailed Wilcoxon rank sum tests as data was not normally distributed for nine out of fourteen group as assessed by boxplot and Shapiro-Wilk test ($p < .05$). *ConnectJewellery* scores for benefits were significantly higher than *ConnectText* on all four benefit items, ($Z = -2.52$, $p = .012$, $r = -.42$) for emotional expressiveness, ($Z = -2.47$, $p = .013$, $r = -.41$) for engagement & play, ($Z = -2.03$, $p = .042$, $r = -.33$) for presence in absence and ($Z = -2.78$, $p = .005$, $r = -.46$) for social support.

A Wilcoxon signed-rank test showed that the differences were non-significant for costs, (Z = -.397 p = .691) for feeling obliged, (Z = -.697, p = .486) for unmet expectations, (Z = -1.15, p = .250) for threat to privacy. Table 15 shows mean and standard deviation for all benefits and costs item for *ConnectJewellery* and *ConnectText*.

ConnectJewellery on average scored "high" for benefits items and *ConnectText* scored "medium" (see Table 15). The average costs of *ConnectJewellery* and *ConnectText* were "low".

Table 15

Comparing Affective Benefits and Costs of Communication Technologies Scale Score for jewellery and Text-Only Phase.

	ConnectJewellery	ConnectText	
Scale	*M* (*SD*)	*M* (*SD*)	*Z*
Benefits			
Emotional Expressiveness	3.55 (1.11)	2.78 (0.77)	-2.52*
Engagement & Play	4.29 (0.78)	3.51 (0.94)	-2.47*
Presence- in- absence	4.25 (0.90)	3.78 (0.51)	-2.03*
Social Support	3.48 (0.88)	2.41 (1.03)	-2.78**
Costs			
Feeling Obligated	1.75 (0.59)	1.87 (0.76)	-.397
Unmet Expectations	1.76 (0.94)	1.79 (0.62)	.-.697
Threat to Privacy	1.14 (0.31)	1.25 (0.29)	-1.15

Note. Z is computed from Wilcoxon Signed Ranks test. * $p < 0.05$, ** $p < .01$.

5.5.3 Qualitative findings

RQ 3: How do parent-adult children maintain contact and how does the *Connect* systems integrate into that experience?

We analysed qualitative data gathered from interviews and open-ended questions from questionnaires to understand the communication practices of parent and their adult children and to evaluate how *Connect* systems may fit into their communication routine.

All transcriptions were anonymised. Names of the participants were replaced by dummy names to maintain anonymity of the participants. We analysed the data from adult children and parents separately. Some of the parent and adult children themes were similar and some complemented each other. We then combined similar themes and noted differences between parents and adult children. Figure 27 shows the two main themes and their subthemes.

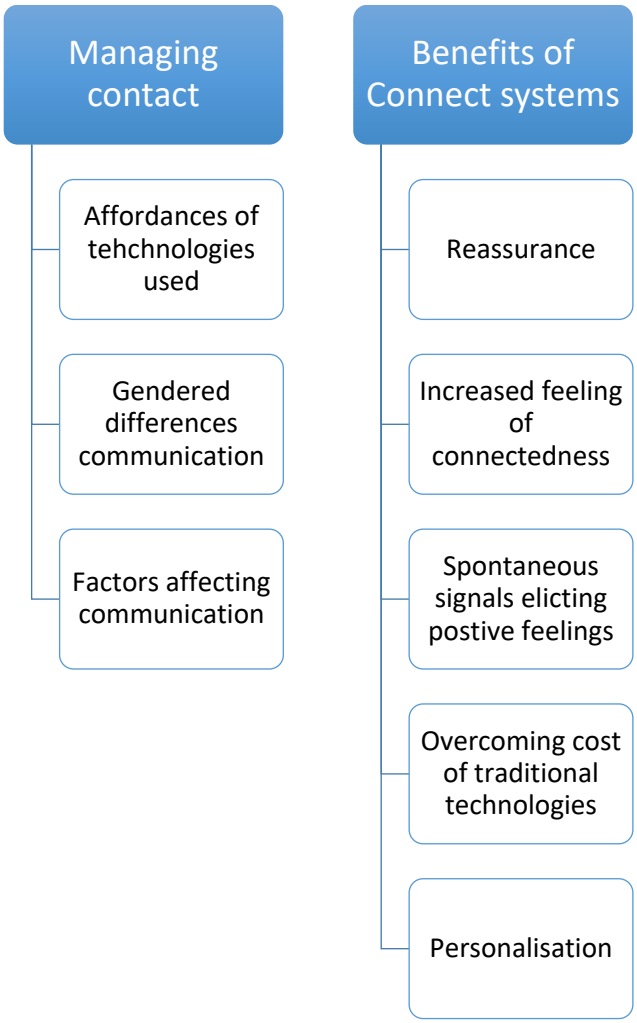


Figure 27. Themes and subthemes from qualitative analysis

Theme 1: Managing contact

This theme describes communication between parents and adult children. It explains the technologies they use, reasons for using those technologies, differences in communication between different relationships and factors that affect their contact when living away from each other.

Subtheme 1.1: Affordances of technologies used:

This subtheme encapsulates different ICTs used by participants and the reasons choosing to use those ICTs. Participants reported using three to four different technologies to maintain contact over the distance. The main ICTs used were mobile phone calls, instant messaging application, SMS, emails, audio-video calls via Skype and social networking websites such as Facebook.

All dyads used different ICTs for different purposes. Most dyads predominantly used instant messenger (IM) such as iMessage or WhatsApp to send messages, share

photos and to keep frequent contact as it was fast, convenient and less costly. Many participants mentioned talking on the phone (including instant messenger calls, landline or mobile phone calls). However, this was less frequent yet for longer duration. Some participants mentioned using emails however this was less frequent and only for formal, work purpose. Some also used Video chat which was similar to telephone calls in that they were less frequent but for longer duration. Some of the other media used included Snapchat, Family IM chats, SMS, social media and online games. A mother mentioned,

> *"We mostly use WhatsApp. Sometimes text messaging. We usually Skype on Saturday, we Skype over the weekend erm... It kind of depends... Sometimes it's just a phone call but we speak anyway on the phone over the weekend. And through the week it's mostly WhatsApp messages we do." P5*

Some adult children mentioned that they tried to set up new technologies for their parents so that they can use different avenues of staying in touch. Some of the adult children's attempt to get their parents to use new technologies were successful where for others they were not. For example, a son mentioned multiple attempts of setting up his mother to use a video chatting application.

> *"She has had a laptop before where I tried to get her to use Skype…. []…. I'm trying to get her into Google hangouts." AC1*

Some of the reasons mentioned for using these ICT were convenience, easiness, fastness, instantaneousness, monetary cost of technology use, ability to share multimedia, and ability to get receipt of 'message delivery' and 'read' status. Some parents used some technologies to passively keep awareness of their adult children's lives. A daughter mentioned synchronous nature and instantaneousness for using IMs,

> *"...main reason for iMessage would be that while it's instantaneous like we can text each other and respond straight away." AC4*

Another mother mentioned ability of sending multimedia, ease of use, synchronous nature, convenience and access to internet as some of the factors for choosing to use IMs or text messages,

> *"We do find that with messenger you can more or less add plenty of things on there as well so it's just quick and easy, because it's instant and so is text. We tend to use text if we're away from home and not on WiFi." P7*

A son who had recently moved to different country mentioned monetary cost as well as convenience allowed by asynchronous types of messages as one of the factors for choosing to use IM or text,

> *"...[we use] more messenger, much more, obviously texts and stuff is too expensive, So we and messages are much ease... Like much more... cause you know I'll, I'll send it when she is asleep, she will reply in the morning so it's kinda easier to keep in touch that way." AC8*

Some other important aspects mentioned for using SnapChat and social media by parents were to be able to passively follow and see their adult children lives and be aware of how they were feeling or doing.

> *"So, I absolutely love being on Snapchat so that I can see both my daughters. To see the fun things they are up to and to see their lives and to follow it." P7*

There were differences in the use of communication technologies people used based on where they lived. Most participants that lived away heavily relied on technologies to keep in touch which was not the case with participants that lived close to their adult children. Most parents acknowledged the importance of communication technologies for their relationship with the distant adult child. Five out of nine parents mentioned having another child living with them or living physically close by so they did not use as much ICTs with these children as they regularly saw them in person.

> *"Because my other daughter lives with me so I see her every day and can physically speak to her every day so erm... We don't really kind of message that much other than to say you know... 'I am on my way home now' or 'can you pick up this or that' so it is different kind of message I suppose. erm... That we have. So yeah, probably message Holly [the distant daughter] more just because she is not around." P5*

Subtheme 1.2: Gendered differences in communication

Participants mentioned distinct differences in communication within different relationship type based on gender. For example, mothers and daughters report being a lot more communicative with each other compared to fathers and sons. Seven out of nine adult children said they communicate much less with their father compared to their mother. One of them mentioned having no contact at all and the other one did not have a father. The seven adult children that do communicate with their father use much less technology with father compared to mother. A daughter mentioned,

> *"We [with father] communicate a lot less and only really by SMS."AC9*

Adult children mentioned that they would contact their mother even if there is nothing to say where as they would contact father less frequently and mostly for practical reasons. Most adult children mentioned the reason for less communication

with father was because their father does not talk as much and when they do, it is mostly for practical reasons. A daughter mentioned,

> *"Yeah, I speak to my dad some, mm, probably less than my mum. He's um, he's more of a practical person so he doesn't really like, as long as he knows that you've got enough money and that I kind of generally all is well and everything's fine at the flat then he's alright. He doesn't really go into many other things erm ... [] .... But I tend call him when I can't get hold of my mum. Or he answers the phone when I call the home phone as opposed to me calling him with the intention of speaking to him. Erm… and occasionally he will like respond on family chat to something that mums sent, or that I've said or something."AC6*

It is important to note that all of the parent participants in our study were mothers and all adult children mentioned having a frequent contact with their mothers. Some adult children said,

> *"I think we talk quite a lot" AC2*

> *"I talk a lot more to my mum."AC4*

> *"So, it would be strange for me and my mother not to talk every day" AC7*

Most adult children mentioned sending text messages (via Instant messenger or SMS) almost every day during the week. Most mothers mentioned either talking 3-4 times a week or a video/ telephone calling for a longer duration on weekend. All dyads reported having a close relationship and were frequently in contact with each other. When asked to a parent about how frequently she was in contact with her daughter, she mentioned,

> *"Mostly every day I would have said. Umm... Just usually depends, it depends on kind of how busy we are I suppose. Yeah, we sometimes kind of you know messaging her 3-4 times you know... though I would wait for her response. If something comes to my head or if I have got something to tell her then I will send her a wee message and she is the same to me so I would say probably daily that we are in contact." P5*

Some mothers that had sons as well as daughters, mentioned sons not being as communicative and that they had more communication with daughters. A mother that took part in the study with her son mentioned her son not being as communicative,

> *"I find that men aren't overly chatty you have to have... when you phone them... you have to have something to chat about." P1*

Subtheme 1.3 Factors affecting communication

Some of the main factors that participants reported affecting their contact with each other were busy schedules of people, time difference, access to technology, personal habits of using technologies and efforts to keep in touch with multiple contacts.

All adult children and six out of nine parents mentioned leading a busy life as one of the main reasons that affect their communication as they did not find time to talk or read and reply to messages. A working mother mentioned,

> *"We both work full time and sometimes you don't have time for long conversations…. []…. if you were busy at work, you wouldn't necessarily notice that you had got a text form him." P1*

The time difference between countries and working at different time also led to needing an advanced planning to arrange a call or video chat with each other. Eight out of nine pairs lived in different cities and they had to organise the time to call each other. A son who recently moved to a far country mentioned distance having a massive impact on their communication,

> *"[The communication has changed] quite a lot, yeah. I mean the time difference and stuff is quite hard to time it right, umm and then yeah just my mum's shifts, like she works really different shifts so it's kinda quite hard and... I think I just get a bit lost in it, especially now because I am just settling in and it's only the first few weeks so it's quite hard to find the time. Well we'd have to plan quite ahead in order to…to talk with her" AC8*

Problems with internet and frustration with technology was another reason that was mentioned by participants which affects their communication. Five out of nine adult children mentioned their parents feel frustrated when technology does not work properly which results in them not using a particular application. A daughter living in a different country from her parents mentioned,

> *"It's generally access to internet is the main source where the communication breaks down, but otherwise, we're generally constantly in contact…. []… [My] both parents get very frustrated by the internet, it provides them very much frustration when it doesn't work properly. So, video calls are even more victim to internet not working properly, so we don't do them because that would frustrate them immensely." AC7*

There were four participants (two adult children and two mothers) that were not allowed to use their mobile phone at work which affected their contact. Also, most participants mentioned their phone habits such as keeping phone in bag, keeping it on silent, not checking phone often, not answering the text or calls right away had an effect on their contact as they missed the calls or text messages on their phone. For

example, seven out of nine adult children mentioned they keep their phone on silent for various reasons such as being at work, not wanting to get disturbed by constant notifications or not wanting to disturb others around. A daughter mentioned,

> *"I get a lot of notifications on my phone anyway so if I was working like usually when I am working at my desk or whatever and I have my phone faced down so if people message me, I don't get distracted and look at it."AC5*

A working mother mentioned,

> *"Your mobile phone can be tucked away in your bag, especially when I'm at work." P2*

Some participants mentioned that they get a lot of messages and emails throughout the day and replying to all of them adds extra time and requires effort. Also, some participants mentioned the process of finding the phone in the bag, unlocking the phone, opening the app, and writing a text to contact someone as a laborious task which may affect their contact with their parents. A daughter mentioned,

> *"sometimes when you've a million emails a day and you've messages from group chats and stuff, doing extra text does feel like extra work. "AC7*

Theme 2: Benefits of *Connect* systems

There were several benefits of the *Connect* systems to the relationship of parent-adult children. These benefits overcame most of the factors affecting communication in the earlier section as well as assisting to the particular needs of this relationship.

Subtheme 2.1: Reassurance

This subtheme encapsulates the need of reassurance of this relationship which was supported by the use of *Connect* systems. Using these systems provided participants with peace of mind of physical as well as emotional well-being.

Almost all participants mentioned a need of wanting to know about each other's wellbeing while living away from each other. Parents wanted to know that their adult children are safe, happy and things are going well in their lives. They cared about emotional as well as physical wellbeing. Whereas the adult children predominately mentioned wanting to know about their parent's emotional wellbeing, such as feeling happy. A mother mentioned,

> *"Normally when I wake up in the morning, I think of her [her daughter] so that's the routine with Nina in the morning 'is she okay? Has she had nice night'." P7*

Her daughter seemed to understand her mother's need and mentioned,

> *"I suppose just to stay in contact and we just tell each other what's going on and also she likes to know, that you know I'm safe and happy." AC7*

Similarly, most other adult children seemed aware of their parent's need of reassurance and knew that their parents worried about their wellbeing. A daughter mentioned her mother being worried if they have not been in contact for a few days,

> *"I forget to respond most of the times. Sometimes I get a text a week later 'alright Katy, I am going to call the police if you don't text me soon' (laughs) 'I am scared that you are lying in dead in a ditch somewhere'."AC4*

One of the needs of adult children was to have an easy way to let their parent know that they are well and safe. By using *ConnectJewellery,* adult children were able to send easy signals to their parents which reassured their parents of the wellbeing of their children. Also, parents mentioned that using *ConnextJewellery* gave them a peace of mind about their son/daughter being okay. A son mentioned using it to let the mother know of his wellbeing,

> *"I was travelling around England quite a lot so it was it was really nice… [] … like we were camping a lot um so I would use it to tell her we were ok and instead of sending a text I would just press the button, to be like oh, she'll know that I can get to my phone and press it, so that's quite nice." AC8*

Subtheme 2.2: Overcoming the cost of traditional technologies

Most participants mentioned costs of using traditional communication technologies. For example, adult children mentioned they feel guilty about not staying in touch with parents enough or forgetting to reply to their parents which may make their parents feel ignored. Also, parents reported worrying or holding back from contacting their adult children as that might disturb them in their busy lives. Most participants reported that these problems were reduced by use of *Connect* systems. There were some costs of using *Connect* systems but only two participants mentioned them.

Adult children mentioned that they are aware of their parents need for reassurance and more contact and they feel guilty for forgetting or replying late and not contacting their parents as much as their parents' desire. Adult children indicated feeling a pressure of talking on the phone for long duration with mothers or having to reply to text messages right away. For example, a daughter mentioned feeling guilty for forgetting to reply to her mother's texts and mother possibly feeling unhappy about it,

> *"...I am the worst child. I mean I forget to respond most of the times... [] ... I can feel a bit of irritation in her [mothers] tone of voice."AC4*

Also, she mentioned that when she and her mother talk on the phone, it cannot be done in few minutes. When they talk, it lasts for few hours. Similarly, many adult children indicated that they would like to have more frequent contact but do not want to have long conversation during those contacts.

Seven out of nine adult children mentioned not feeling pressure to reciprocate to signals received via *ConnectJewellery* suggesting using *ConnectJewellery* could help lower the sense of guilt adult children feel. For example, a daughter mentioned that using *ConnectJewellery* with her mother allowed her to maintain the connectedness without frequent calls and made her mother feel more connected. When asked if using jewellery affected their communication, she mentioned,

> *"When we were keeping contact [using Jewellery], whenever I did get message or did send messages, they were lot more like... it seemed a lot more like... Especially from her [mothers] side 'oh we are keeping in contact and you haven't disappeared out of for my life for days that you usually do.' (Laughs) which was nice. So it made it okay to not talk several times. It made it okay if we missed talking to each other for like a whole week. We were both fine with it because we knew that the other person is right there." AC4*

Interestingly, seven out of nine parents mentioned that they do not want to disturb their adult children thinking that their adult children have busy lives and they do not want their adult children to feel pressure to reply right away. A mother mentioned,

> *"When somebody is in different country, doing their own work, they are really busy you don't expect them to have time to you know, emailing or WhatsApping or whatever." P7*

ConnectJewellery assisted in this scenario as the parents felt they were not burdening their adult children by demanding a response but gently letting them know that they were thinking of them. A mother mentioned,

> *"I just want to say 'gosh, just thought of you', press the thing, off it goes and it's over. You know you don't have to follow up, you don't have to do anything, there is no work there is no pressure, and she doesn't have to do anything. She just accepts it and it doesn't interrupt my daily routine, her daily routine, and there is no pressure on us to reply or respond." P7*

Another mother mentioned that she and her daughter did not have to plan in advanced and could keep in touch using *ConnectJewellery* without disturbing each other.

> *"I think the best thing was to know to get the feeling of 'oh that's nice' 'how nice' but you only dwell on it for a short period of time. And that do not disturb each other's daily life. So, you don't have to plan for FaceTime that's really good. Loved it! (Laughs)" P4*

Sixteen out of eighteen participants specifically said they liked using *ConnectJewellery* as it was easy and very little effort to send signals and overcame the costs that were introduced by using other traditional communication technologies. Some of the factors mentioned in the subtheme 1.3 such as technology frustration, effort, busy schedule that affected communication between parent and their adult children were also addressed by using *ConnectJewellery.* A working mother mentioned about how *ConnectJewellery* was less effortful than other methods of communication and yet highly rewarding,

> *"I think it just very easy, simple, uncomplicated, untechnical, non-technical way to keep in contact with somebody. And there is no pressure on anybody and the reward is so much higher than any of the other methods of communication. Because the other methods of communication all demand a response. You have to do something. You know you kind of have to answer it which means you have to take off the keyboard, take off the phone and start pressing the letters and it's just work! Where this was no work. It's kind of like um... it's kind of like the most simplest form of love. When you have baby you just kiss them, because you just wanted to kiss them cause its just natural and lovely thing to do and there is no hard work on either side. The baby just got to accept it, you just give it. It's same with the Ringly you know you are saying 'thinking of you' and the person has to do nothing, and you have to do nothing it's just natural and it's just nice!" P7*

Although most participants reported that *ConnctJewellery* did not make them feel as if they had to send signals, one participant mentioned feeling sad when one day she did not get many signals on her jewellery. She mentioned,

> *"Towards the end of the study my mum kind of stopped pressing it. Um then I felt sad cause it was going the whole day and I was like but you used think of me so much, but you don't any more (laughs.)" AC6*

The *ConnectJewellery,* allowed connection between only two people and also the vibrations were subtle. The signals via jewellery were shared only with the person that wore it therefore ultimately reducing 'threat to privacy' cost which is often associated with other communication technologies. Participants mentioned that the signals were discrete, intimate and non- intrusive. For example, a daughter mentioned,

> *"Vibration I thought was perfect, it didn't make a noise, and it didn't draw anyone's attention but mine." AC2*

However, she also mentioned some concern about others seeing the flashing light of the jewellery. She did not like flashing light on jewellery especially in formal situations such as meetings, as she would not want others to see the light and know that her mother is thinking about her. She mentioned,

> *"The light I could have done without with. I don't think it really added anything, but it drew people's attention to it which is fine in some situations like when you're at the pub but when I may be in a meeting with my supervisor (laughs) you don't really want your ring flashing." AC2*

There was an option of deactivating the light in jewellery which resolved this issue.

Subtheme 2.3: Increased connectedness via vibro-tactile signals

Eight out of nine dyads said that they felt more connected when using the *Connect* systems. Participants reported having more connection throughout the day which they would not normally had, it was easy to use, non-intrusive and could be used even when busy. Additionally, participants reported the synchronous, immediately felt vibro-tactile sensation via *ConnectJewellery* made them feel more connected rather than *ConnectText.*

Fifteen out of eighteen participants mentioned they would continue to use the *ConnectJewellery* if they had one. 15 participants actually did continue to use *ConnectText* even after the study was finished. However, fourteen out of eighteen participants mentioned they preferred *ConnectJewellery* over *ConnectText* system. Participants mentioned that although it was nice to get the texts of 'thinking of you', the tactile sensation received via jewellery was preferred over the text. The reasons for liking jewellery over text was that the experience of getting text was not much different than normal SMS or instant message. If participants did not have their phone with them or if it was on silent, they saw the text later on. Where with jewellery the signals were felt immediately, and the tactile sensation was discrete. Therefore, only the person wearing the jewellery felt it, unlike phone vibrations which may grab the attention of people around. A daughter mentioned,

"With text, like I said I have to get my phone out and sometimes my phone would be away from me, in my pocket or my bag. Um... I would have to hear it and open on my phone and then it shows that my mum has thought about me. It comes up with. I mean on the main screen it shows me how many times and what's happened in the four hours that I haven't checked my phone. it will be like 5 times that she has sent me a message which is nice and its meaningful like that she has thought about me 5 times in last 4 hours and its cute, but I only find out afterwards. Whereas with the ring I found out straight away. So even though I am super busy, and I am doing stuff and I am like I don't have time to look at my phone but I can feel that she is thinking about me at random specific whatever times over the last 4 hours rather than having to wait to look." AC4

In situations where participants either busy or could not check their phone or did not want to get distracted by many other unimportant notifications found *ConnectJewellery* particularly beneficial as they were still able to wear the jewellery at work and feel the vibrations of the signals of 'thinking of you' from their study partner. Some mentioned that they did not have much to talk about yet wanted to stay connected which is what *ConnectJewellery* allowed them to do. A mother mentioned,

"I thought it [Jewellery] was nice. Um... I felt connected in Mark's day and I hope he felt connected in my day. Um... so if he was to phone him every night, he would run out of things to talk about. Because it is only every day stuff. You can only tell your mum once that you are going to go to hen ball or you are going to go to rugby. Um... whereas the Jewellery, it's nice, it makes you feel connected, it's not intrusive, and you can do it at any time. So if you are rushing off to rugby or something, Mark could still do it." P1

Eight out of nine pairs mentioned that the jewellery was an additional way of maintaining connectedness without impacting their usual communication. Some also suggested that they had increased communication as sending/receiving signals via jewellery sometimes reminded them of things to tell each other.

A daughter mentioned,

"I can't always be bothered to message her but sometime if I'm busy during the day so pressing that button was so much easier to let her know that I was thinking about her but I did not have to spend like 15 minutes and write a message.... []… I think it was

just nice addition to like that little bit communication during the day that I would not otherwise have spoken to her." AC5

Subtheme 2.4: Spontaneous signals eliciting fleeting feelings

Sixteen out of eighteen participants mentioned that using *ConnectJewellery* elicited positive feelings. They mentioned that the spontaneous nature of signals elicited feelings of surprise and excitement. Especially with *ConnectJewellery*, signals were sent/received at random times, providing immediate gratifications which some participants saw as fleeting gifts. A mother mentioned,

"I just took it as face value as a lovely gift for me in this moment in time that I have to do nothing about but cherish…. []…. The other part it was spontaneous. That you could do it outside of those routine times. So the spontaneity is what I appreciated and I really enjoyed and I think adds real value to the Ringly is the spontaneity, that you can leave the routine, that you can add in these extra times just to say thinking of you but you don't have to dwell on it you know just 'thinking of you'." P7

All participants mentioned the experienced with *ConnectJewellery* elicited various positive feelings. They mentioned feeling content, calm, happy, warm, cared for, loved, valued, comforted, connected and close. Some participants mentioned that the signals shared only between the two as opposite to many, created an exclusive, more meaningful connection between them. A mother mentioned various positive feelings,

"[it made me feel] really warm, fuzzy, happy, content. I feel of that's nice you know kind of nurturing erm... So, for me, I felt kind of valued, a sense of being in contact, being close. A sense of this is just really nice. So I felt it was lovely!" P7

Some participants said it made them feel happy if they were having a bad day. A son mentioned,

"We really enjoyed um, yeah it was a really nice touch and especially if I was having a long day or um really crappy day"AC8

Subtheme 2.5: Personalization & design

Personalisation of the *Connect* systems was an important factor. Participants mentioned that they liked that the messages could be personalized if they wanted to and that they could change the vibration pattern and the colour of the light. A pair that was originally from Poland set up the system to exchanged 'Thinking of you' signals in Polish rather than English. Another pair changed it to 'love you' rather than 'thinking of you'. A mother said,

"Actually I changed it to 'I love you' (laughs). Or I think it was like 'love you' (laughs) so I changed it." P4

All of the mothers and six daughters said they loved the design of the jewellery. However, five daughters mentioned that they would prefer a smaller, more delicate designs than a big stone on the jewellery. Two daughters and two sons out mentioned not usually wearing a jewellery and a son mentioned he would have preferred a design similar to a watch instead of the jewellery. A daughter mentioned,

"As I said I don't normally wear jewellery so it was a bit taking getting used to. But I mean it was nice, it wasn't like…. I was happy to wear it." AC5

One of the main design drawbacks mentioned was the button being a virtual button on the phone instead of directly on the jewellery. Almost all the participants mentioned that they would have preferred the button on the *ConnectJewellery* itself. A mother mentioned,

"You know where the stone was if you could just press that back [to send signals] that would have been really lovely." P1

5.6 Discussion and findings

This study was intended to explore how wearable IoT devices using connected smart jewellery could support long distance parent adult children relationships. We designed a prototype called *ConnectJewellery* using 'off the shelf' smart jewellery that would allow sending vibrating signals to each other's Jewellery. This was a symmetric (2-way), synchronous system that used tactile vibrations coupled with small flashes of light to express the feeling of 'thinking of you'. We compared it to *ConnectText* system which sent the same signal via text messages or emails on a participant's mobile phone.

We used connectedness and closeness as the main theoretical concepts to evaluate these artefacts along with measuring the affective benefits and costs of them. We used a mixed method approach to quantitatively measure connectedness, closeness, benefits and the costs of these systems as well as qualitatively assessing the experiences of our participant of using these systems.

There were two main hypotheses. The first hypothesis was that the *Connect* systems will lead to higher level of connectedness than regular contact using traditional ICT. This hypothesis was supported. The RQ1 results indicated that our participants felt more connected during *ConnectJewellery* as well as *ConnectText* phase compared their regular contact using traditional ICT before starting the study. As compared to pre-study, connectedness for both connect system was significantly higher. We did not find a significant difference in connectedness during *ConnectText* and post-study

which could be because of 15 participants continuing to use the *ConnectText* even after they were asked to stop using the system, which could have maintained their connectedness level similar to *ConnectText* phase. This is an important finding as a participant were not under any obligation to use *ConnectText* after the study. However, they continued to do so supporting the benefits of such systems to this relationship.

Some of the reasons for the continued use of *ConnectText* could be that they found value in sending the phatic 'thinking of you' signals as an additional way of maintaining connectedness. In addition to connectedness and closeness, participants mentioned that receiving these messages elicited various positive feelings of happiness, being cared for, being loved, excitement, surprise, calmness and contentment. It also reduced a sense of guilt for adult children and provided a sense of reassurance for parents as well as adult children.

The findings also confirmed our second hypothesis; the *ConnectJewellery* will lead to higher level of connectedness and affective benefits than *ConnectText*. Findings of RQ 1 and RQ 2 showed that the difference between the levels of connectedness felt during of *ConnectJewellery* phase was significantly higher than the *ConnectText* phase. ABCCT questionnaire also indicated that the benefits of *ConnectJewellery* were significantly higher than *ConnectText.* Participants reported high scores of all benefits and low scores of costs associated with *ConnectJewellery*. It means that the signals received via jewellery were emotionally expressive. They also allowed for engaged, playful interaction between the participants. It was also evident from qualitative findings where participants mentioned they 'buzzed' each other multiple times just for fun. *ConnectJewellery* scored high on the presence in absence which refers to emotional closeness and connectedness which was also supported by qualitative findings. Using jewellery also provided emotional support of 'being there' for them. This refers to a general sense of someone being available for you which has been reported to make people feel loved and reduced negative feelings such as by soothing anxiety.

In addition, to quantitative, qualitative data supported these finding where fourteen participants mentioned that they preferred *ConnectJewellery* over *ConnectText* and fifteen mentioned that they would continue to use it if they had the *ConnectJewellery*. The reason mentioned was because the *ConnectText* was very similar to receiving messages on the phone using traditional ICT. The *ConnectJewellery* was a wearable device which allowed the synchronous signals providing immediate gratification as opposed to receiving a text which was not always noticed. Also, participants mentioned that the vibro-tactile nature of the signals allowed them to feel the messages. Another reason could be the design of the jewellery was liked by most participants making it a more wearable as opposed to a techy looking device. Our participants felt closer during *ConnectJewellery* phase. This could be because closeness and connectedness are correlated concepts hence

supporting connectedness could have had an effect on feeling more close. Theme 2.3 on increased feelings of connectedness, further explains how *ConnectJewellery* allowed for an easy way of maintaining connectedness and closeness. The synchronous nature of signals received via wearable also allowed participants to stay in sync with each other's daily activities.

These findings are supported by previous research. For example Bales et al. (2011) reported increased feelings of connectedness between romantic partners when they received awareness information via vibro-tactile cues. Among the previous studies related to remote tactile communications between long-distance romantic relationship, Park, Baek, and Nam (2013) stated that when emotions are expressed using tactile sensations, it supports the sense of closeness between the couple. Our qualitative, as well as quantitative findings, support this in terms of parent and adult children. To our knowledge, this was the first study that explores the use of smart jewellery to support connectedness between parents and adult children relationship. Also, this was the first study to provide solid evidence that use of wearable technology to exchange affective phatic signals could significantly increase connectedness compared to traditional text messages.

Previous social science researchers have reported that parent and adult children commonly worried about one another (Hay, Fingerman, & Lefkowitz, 2007). This was supported by our findings in this study as well as *SmartLamp* study. *ConnectJewellery* provided an easy way to provide peace of mind of each other's physical safety as well as emotional well-being. As mentioned before, Yarosh et al. (2014) argue that most communication technologies have some affective benefits and some affective costs of using them. The quantitative findings of RQ 2 and qualitative findings of RQ3 show that *ConnectJewellery* have high affective benefits and negligible affective costs. Particularly, previous research mentions obligation for reciprocity as one of the main costs of communication technologies (Bales et al., 2011; Hassenzahl et al., 2012). In terms of parent-adult child relationship, our findings show that it is mainly adult children that feel a sense of guilt for not staying in touch with parents as much as their parents need which is a cost introduced by other communication technologies. We found that *ConnectJewellery* reduced this obligation of reciprocity felt by adult children.

Our findings indicate that wearable IoT artefacts such as smart jewellery could be beneficial in maintaining long-distance parent-adult child relationships for a number of reasons. Qualitative and quantitative analysis showed several benefits of the *Connect jewellery* systems. In addition to supporting closeness and connectedness, it supported specific needs of parents and adult children, for example, an easy way to reassure each other of their well-being, reduce the sense of guilt adult children have for not replying or not staying in touch with parents.

5.7 Limitations and future direction

Although using 'off the shelf' IoT technologies provided us with the system that would reliably work in the field, it also became one of the mains limitations of this study as it did not provide us with all the features that we intended to have in the system. The initial design of the jewellery had the button on the jewellery itself so that user would never have to use a mobile phone to send 'thinking of you' signals. Also, the initial design provided three different interactions to allow sending three different types of signals. For example, pressing the button once, holding the button for a short duration and double pressing/tapping the button to send three different types of combination of vibration and light. This would give the user flexibility to send more than one signal yet keep the system simple enough so that user does not forget the meanings of those signals. However, at the time when this study was carried out, there was no jewellery on the market that had a button on the jewellery itself, therefore, we had to modify our system design to send signals using the virtual button on the mobile phone which hampered the overall user experience.

Another limitation was that although the beautiful feminine designs of the jewellery made them popular amongst the female participants, it was also a limitation in a sense that we did not find many male participants that wanted to wear the jewellery. When the effort was made to engage more male participants, they mentioned in that it unsuitable to their personal style and they would have been interested in participating in the study if the jewellery was in a discrete place (inside their clothes and not visible from outside) or if the design was gender neutral or suited their style, e.g. a leather strap or a watch. The two male participants (adult sons) in the study also mentioned that they do not normally wear jewellery, however were motivated to participate in the study as they shared a close connection with their mothers and thought it would be a nice thing to do with their mothers. This could also be seen as a finding to suggest that adult and their parents want to engage in activities together, therefore, devices that allow for 'the joint action' strategy (as mentioned in literature review section 2.7) would be meaningful to this relationship. This could be explored further in the future work.

Some participants mentioned that they would like to use *ConnectJewellery* with other family members, especially elderly that find it difficult to travel, close family and friends who are going through difficult times to send them 'thinking of you' messages. This could be interesting to further explore the effectiveness of the jewellery to provide connectedness to investigate how well they benefit these relationships.

5.8 Conclusion

This study provides two key findings, firstly that an expressivity strategy to send affective messages evokes a strong sense of connectedness and closeness between parent-adult children, offering high affective benefits with low affective costs to the relationship. Secondly that the vibro-tactile signals received via wearable artefacts such as digital jewellery are more meaningful than screen-based technologies such as text messages on mobile phones. To conclude, it can be said that the affective experience of connectedness can be evoked by vibro-tactile notifications of 'thinking of you' messages, when these communications mesh with, rather than replace, existing communication habits to support relationships of distant loved ones.

6 Chapter: General discussion

This thesis has explored the effectiveness of two systems that were designed by appropriating IoT technologies to support distant parent-adult children relationships. The preceding chapters have also explored current communication practices and how connectedness can be supported in this relationship. This Chapter will now review and summarize the findings which were uncovered, their relevance to the existing work in the field, as well as future applications and the limitations of the research presented.

This thesis makes some empirical and theoretical contributions to the psychology as well as the HCI field. There are four main empirical findings, firstly, awareness provided by artefacts embedded in surroundings and expressive phatic signals exchanged using wearables both can elicit positive feelings of closeness and connectedness. Secondly, expressivity might be a better design strategy than awareness for supporting emotional connection between parent-adult child relationships. Thirdly, connectedness might be the more suitable concept than social presence for evaluating communication technologies designed for close interpersonal relationships. Finally, based on the findings of all three studies, we present six affective design implications and seven practical design recommendation that would be useful for the future researchers or designers while designing technologies to support connectedness.

There are three main theoretical findings. Firstly, this thesis contributes to the area of communication studies by providing an understanding of how parents and adult children use ICT to maintain relationships over distance. Secondly, it gives an understanding of desired connectedness in this relationship and that increasing the feeling of connectedness can have a longer-term impact on parent-adult child relationships through increasing the feelings of closeness towards one another. Finally, it adds to the understanding of the needs and dynamics of this relationship.

The key findings of this thesis will now be broken down into three sections. How this thesis as a whole contributes to these findings will be discussed along with how they fit into the wider context of existing literature and their implications for the wider field. The first section that will be discussed is this thesis's contribution to the area of IoT use to support parent-adult child relationships.

6.1 IoT technologies to support parent-adult child relationships

One of the first research questions of this thesis was if and how IoT technologies can support closeness and connectedness in parent-adult child relationships and what are people's experiences using the *SmartLamp* and *ConnectJewellery.* We explored this by designing two artefacts using off-the-shelf IoT objects. We used awareness and expressivity strategies to understand if these may support connectedness and

closeness in a parent-adult child relationship. In Chapter 3 we found that awareness created by technology embedded in a user's surroundings and conveyed using light can significantly increase closeness in the relationship. In Chapter 5 we found that expressive phatic messages received via wearable technology conveyed using vibro-tactile sensation can significantly increase connectedness and closeness in parent-adult child relationships.

The *SmartLamp* study in Chapter 3 explored whether awareness, created using everyday artefacts situated in one's surroundings, could foster feelings of closeness in parent-adult child relationships. Specifically, whether the use of an asymmetrical awareness system, the *Smartlamp*, increased closeness in comparison to other media such as email, Facebook and Whatsapp. A longitudinal study was conducted with six pairs of adults and their parents over a four-week period. The communication behaviours of participants with and without the *Smartlamp* system were observed. Measures of daily closeness were collected using an adaption of the Inclusion of others in the self (IOS) scale presented within a diary while qualitative data was collected through semi-structured interviews. Results revealed that pairs had more contact during the phase they used the lamp and parents reported feeling closer to their distant child on the days they used lamps. Quantitative data revealed a significant increase in closeness in the first week of using the lamp. Closeness measures on the days the pairs only used the *Smartlamp* were equivalent to those when they used other media to communicate or met face-to-face and significantly closer than when there was no contact. This study provides evidence that very simple awareness systems can enhance feelings of closeness.

As discussed in Literature review reported in Chapter 2 (see Section 2.7.1), awareness has been the subject of research in HCI and CSCW since early the 1990s (Rittenbruch & McEwan, 2009) and there have been a number of artefacts designed to support awareness, however they were not focused on parents and adult children relationship. They also do not explore how IoT technologies can be appropriated to create prototypes that reliably work in the field. Very few of the artefacts were field tested to understand their effectiveness for their users. The *SmartLamp* study is the first to demonstrate empirically that users of such awareness artefacts appropriated using IoT technology can experience increased closeness using both objective and subjective data.

Our findings support those of Dey and de Guzman (2006) that argue that technology designed using everyday objects could provide better connectedness and awareness of loved ones than graphical user interfaces. Their study focuses on online presence when a person is using the internet on their computer. We argued that this type of awareness information might not always be appropriate in parent-adult child relationships as being online does not always mean that a person is available. As Keller et al. (2004) found that parents may miss the daily moments of coming home of their child. The *SmartLamp* study reported in Chapter 3 was the first study that

explored the effectiveness of awareness information providing peripherally to parents about their adult children's arrival and departure using artefacts already available in their environment. This recreated naturally occurring incidences when family are co-located. The awareness of the adult child's coming and going from home supported a sense of closeness for parents as it increased the frequency of contact between the dyads as well as creating awareness of the routine of their adult children, therefore, they would be able to tell their availability to be able to contact them. Some of our participants reported that they could visualise their son or daughter in their home and felt reassured about their well-being.

Through the *SmartLamp* study reported in Chapter 3, we explored the effectiveness of an asymmetrical system which attempted to recreate the moment of coming home of adult-child. The results of this study suggested that parent and adult children both desire connectedness therefore for our next design, we decided to design a symmetrical system which allowed parents as well as their adult children to send messages to each other. In the *SmartLamp* study, the lamp was situated in one place, and if the person was not at home, they would miss these signals. We needed a design solution that would provide the sense of connection anytime anywhere and explore how that might help this relationship. In the study, the lamp was triggered automatically; we needed to explore what happens when people specifically wanted to make others aware of them. Also, in the *SmartLamp* study, we found that for the parents the lamp became like a proxy of the adult child, in a sense that the object became meaningful itself. Even after the lamp was no longer a *SmartLamp*, a few parents still felt attached to it as it reminded them of their child. Similarly, other researchers (Wallace, 2007) indicate that people have meanings attached to objects such as physical photos, artefacts received as gifts and jewelleries (Silina & Haddadi, 2015a). This inspired the design of our next system, *ConnectJewellery* which was a symmetrical, synchronous system which allowed exchanges of phatic 'thinking of you' signals felt via a vibro-tactile sensation.

The *ConnectJewellery* study reported in Chapter 5 explored whether the expressive phatic messages exchanged using vibrating wearable jewellery could support the feeling of connectedness and how this compares with the same messages received via text. We wanted to explore whether sending phatic messages makes a difference in the connectedness in parent-adult child relationships and also if the type of media used (wearable vibro-tactile vs traditional mobile phone text messages) to send these phatic signals makes a difference in this relationship. This was explored by designing two symmetrical expressive systems; *ConnectJewellery* and *ConnectText* and evaluating whether they increased connectedness and closeness compared to other traditional communication media that is used to maintain relationships. The communication behaviours of participants before using either of the systems, during the use of *ConnectJewellery*, during the use of *ConnectText* and after the use of these two systems was observed. Measures of closeness and connectedness were collected twice a week, and affective benefits and costs (ABCCT) scale was used to compare

the benefits and costs of the both *Connect* system after participants stopped using these systems. The qualitative data was collected using open-ended questionnaire sent twice a week and interviews conducted at the end of the study. Results revealed that connectedness experienced during *ConnectJewellery* phase was significantly higher than *ConnectText.* Also, the connectedness felt during the use of both *Connect* systems was higher than before they used these systems. There was no difference in connectedness felt during the *ConnectText* and one week after the study was concluded which could be because 15 out of 18 participants continued to use the *ConnectText* after the study even when they were asked to stop using the system. Fourteen out of 18 participants preferred *ConnectJewellery* over *ConnectText* and said they would use it if they had one.

Participants reported having a very positive experience while using the jewellery. Other than closeness and connectedness they mentioned it was an emotional boost to know someone is thinking of them, it made them feel happy and calm, close and warm, content, made them feel that they were cared for and valued. Receiving messages were seen as lovely fleeting gifts. People mentioned because the signals received were spontaneous and random and that it was exclusively shared only between the two which made it special. The explicit action of sending a signal in addition to frequently sent signals both added to the feeling of connectedness and closeness. Participants also reported that using the *ConnectJewellery* overcame the drawback of traditional media- e.g., less obligation to respond, less threat to privacy.

As mentioned in the literature review (see Chapter 2) there have been a number of artefacts that employ expressivity design strategy to send phatic signals that claimed to support connectedness in a distant relationship (Bales et al., 2011; Chang et al., 2002). However, none of these studies directly measured nor defined connectedness and just inferred their devices effect through interviews with participants. Also, these studies designed their artefacts for connecting romantic partners, and to the best of our knowledge, there is no study that explores how expressive phatic signals can support parent-adult child relationships. The findings of the *ConnectJewellery* study, through quantitative and qualitative measurements of connectedness, for the first time provide solid evidence that devices that use expressivity strategy to send phatic signals do indeed increase feelings of connectedness for parent-adult child relationships.

The findings of Chapter 3 and Chapter 5 report that the *SmartLamp* and *ConnectJewellery* have some affective/ emotional benefits and some costs of using these systems. It has also been found by Yarosh et al. (2014) that most communication technologies often have some emotional benefits and some costs of using them. The *SmartLamp* and *ConnectJewellery* both provided reassurance of well-being and supported the feeling of closeness and connectedness. *SmartLamp*, however, was able to provide awareness of availability which was not provided by *ConnectJewellery.* However, *SmartLamp* suffered from costs such as intrusiveness,

where some parents felt they might be intruding on their adult children's lives. Also, for a few parents especially the ones that tended to worry more, it caused a feeling of worry if the lamp did not switch on. Although, none of the participants mentioned the intrusiveness of light turning on-off if the lamp was not small and if it was not placed in the living room, it could have been intrusive to the people living in parents' home. Also, other people that came to parent's home could see the light on, and although most participants said it was a conversation starter and also elicited positive feelings for other family members in the home, it could also be seen as a threat to the adult child's privacy. These costs were not associated with *ConnectJewellery*.

It can be said that *ConnectJewellery* was more successful in supporting this relationship than the *SmartLamp* for a number of reasons. Firstly, the expression of 'thinking of you' signals seemed to have high affective benefits for the relationship. Secondly, it does not have many costs; only one participant mentioned the cost of unmet expectations where she felt a bit upset when she did not get as many signals from her mother as she wanted. Thirdly, *ConnectJewellery* even reduced the cost introduced by other communication technologies, e.g., it reduced the feeling of guilt many adult children feel for not staying in touch with their parents as much as their parents want. These findings suggest that although awareness and expressivity are both beneficial strategies to support this relationship, expressivity might be more effective and more beneficial to support parent-adult child relationship than awareness. However, care must be taken while generalising this for all awareness and expressive artefacts as the design of the artefacts plays an important role in the experiences of the user. The point is that expressing affectionate messages might create more of an emotional bond as it elicits the feelings of cared for and valued. As some of our participants mentioned, it gave them an emotional boost to know that their loved one was thinking of them and they had a very positive experience of using *ConnectJewellery.*

Overall both *ConnectJewellery* and *SmartLamp* demonstrated their use alongside traditional media was successful for supporting connectedness and closeness within parent-adult child relationships. This can be explained in the context of media niche theory which posits that newer technologies will either compete with older technologies if they seek to fulfil the same need, or they can instead complement older technologies because the newer and older technologies fall into different niches. Kuwabara et al. (2002) argue that the traditional communication technologies are content-oriented and there is a need for connectedness-oriented technologies for interpersonal relationships. Out findings supported this argument as *ConnectJewellery* and *SmartLamp* which are connectedness-oriented technologies indeed provided a complimentary benefit alongside traditional communication technologies.

6.2 Social presence vs connectedness

In Chapter 3 we initially aimed to use social presence to evaluate the *SmartLamp* as it is a popularly used concept to evaluate communication technologies, (see Davis et al., 2015; Gooch & Watts, 2010). However, we found that it may not be appropriate to evaluate awareness or expressive technologies. There are currently a number of competing definitions of social presence, and the concept is ill-defined. For this thesis, we chose to use the original definition of social presence given by Short et al. (1976, p. 65) "degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions" which refers to feeling of 'being together' in mediated communication. This feeling is temporary and dissipates soon after. Short et al. (1976) refer it to as a quality of a medium. Therefore social presence experience in face to face, or video chat will be higher than email or SMS.

Following this definition, social presence might be suitable for studying technologies that are aimed at supporting the feeling of presence or togetherness in that moment. For example, distant educational technologies (where the feeling of being together with a distant teacher or student might be of interest), video communication technologies (where again, the feeling of being together with other person while communicating in that moment is of interest), and technologies that support synchronous join action (e.g., cooking together, playing synchronous online game together). This might be the reason why it is so popularly used to evaluate online learning/ eLearning platform tools (Biocca et al., 2003; Tu, 2002). However, for technologies that want to support a relationship over the long term, social presence may not be a suitable measure, due to its short-lived nature.

In the *SmartLamp* study, we used the Semantic Differentials measure of Social Presence which was developed by Short et al. (1976). The reasons for selecting this measure included the fact that it had been used by other researchers, e.g., (Gooch & Watts, 2014; Hauber, Regenbrecht, Hills, Cockburn, & Billinghurst, 2005) and had sufficient validation and verification for our purposes. A number of participants reported that they found it difficult to use the measure as they could not understand the connection between the terms used and their use of communication technologies. `Large' and `Small' in particular were hard to relate to their relationship. This questions the appropriateness of the questionnaire for capturing social presence accurately. Currently, there is no suitable measure which can reliably measure social presence to be effectively used in the evaluation of communication technologies. As an element of further work, it would be useful to develop a reliable, verified method of assessing Social Presence.

Unlike social presence, connectedness is an emotional experience, evoked by, but independent of, the other's presence and is linked to awareness as well as how frequent the people are in touch. In the *SmartLamp* study, we found that the effect of

the *SmartLamp* on social presence was very low, but the qualitative findings showed that the sense of connectedness was high. This provides evidence for the argument made by Rettie (2003) that although social presence has received more focus in previous research, connectedness is a more fundamental concept and is a key concept in the analysis of communication and development of communication technologies. Due to the issues found with using social presence as a measure, and from the findings of the *SmartLamp*, subsequent chapters focused on connectedness as a phenomenological concept. The findings of the online survey in Chapter 4 and the *ConnectJewellery* study in Chapter 5 provided further confirmation that connectedness is a more suitable concept for the analysis and development of communication technologies.

6.3 Connectedness and closeness

The observation of the communication between the dyads and the needs of parents and adult children during the *SmartLamp* study in Chapter 3, showed that both dyads desired a sense of connectedness with one another. However, parents need for connectedness seem to be more than their son/daughter. This was further explored to verify if these findings could be generalised by studying a large number of people. We carried out two survey studies to understand adult children and parents' perspectives about their desire for connectedness and actual connectedness in a relationship. It was found that adult children and fathers desired significantly more connectedness than they actually have but the difference was not significant for mothers. It was also found that parents desired connectedness was significantly higher than adult children's desired connectedness. These findings could be explained by intergenerational stake hypothesis which posits that parents are more invested in their adult children than adult children are in their parents (Bengtson, 2001; Bengtson & Kuypers, 1971). In our knowledge, this is the first study that provides solid evidence for parents and adult children's desire for connectedness when living away from each other. This finding is a key indicator that there is a need for designing novel technologies to support connectedness in this relationship.

The online survey also explored if there was any association between connectedness, closeness and relationship satisfaction. We found a strong correlation between connectedness, closeness and relationship satisfaction reported by adult children and mothers however no association was found between these variables reported by fathers. This supports the findings of Rastogi and Wampler (1999) who also found a correlation between connectedness and closeness. However, their study focuses on mother-adult daughter relationships, and the connectedness is defined as an ability to share feelings and opinion as well as making sacrifices. Their definition of connectedness includes emotional closeness, attachment, support and intimacy in a mother-daughter relationship and it does not take communication or contact into account (Rastogi, 2002). Similarly, there are a few other studies associating connectedness, closeness and relationship satisfaction yet their definitions of

connectedness are different and do not necessarily refer to the feeling of being in touch (Miller-Day, 2004; Onayli & Erdur-Baker, 2013; Rastogi, 2002). To our knowledge, this is the first study to report the association between connectedness, closeness and relationship satisfaction between parent-adult child relationships.

The findings of this study are interesting from a theoretical perspective and useful from a practical perspective. The strong correlation between connectedness, closeness and relationship satisfaction helps broaden our understanding of connectedness in the context of personal relationships. It could be said that by creating technologies that help increase connectedness, designers have the potential to help support personal relationships in a more meaningful, long-term fashion. Practically these findings encourage the use of connectedness as a measurement technique within a closeness context. The technologies that are associated with high or low levels of connectedness may have an impact on the relationship's feelings of closeness, and subsequently the state of the relationship more generally. The strong positive correlation between connectedness and closeness and relationship satisfaction further validates our choice to use it as the concept to support long-distance relationships.

6.4 ICT use by parents and adult children to maintain a relationship

A part of a research question of this thesis explored how parents and adult children use traditional technologies to maintain their relationship over a distance. There were three main reasons for this exploration. Firstly, we needed to understand how they to maintain relationships to be able to compare it to how our technologies integrated into their communication routine and if the addition of this technology would have any benefit on their relationship. Secondly, we sought to understand how the technology use affects their relationship by exploring associations between the total number of technologies used and frequency of contact with connectedness, closeness and relationship satisfaction. Thirdly, we sought to gain a better understanding of what factors affect the technology use (distance, age) and the dynamics of the relationship around technology use (depending on the relationship type) which would inform novel designs to support this relationship.

All three studies found that parents and adult children have a high frequency of contact and a close relationship with parents. This supports the findings of previous studies where an overwhelming majority of adult children report feeling emotionally close to their parents (Golish, 2000; Lawton et al., 1994). The online survey study showed that the frequency of contact with the mother-daughter relationship is highest and the father-son relationship is lowest. Also, adult children reported feeling closer to their mother compared to their father. These findings supported gender theory which focuses on the gendered pattern of family interaction, suggesting woman are more involved in adult child-parent relationships because they often give higher

importance to close emotional bonds with family members (Lye, 1996; Silverstein et al., 1995; Tao, 2014)

All three studies suggested that at this point in time people used between 3 to 5 total technologies to keep in touch. Their closeness and relationship satisfaction was also high, and we found a strong correlation between the number of media used to the frequency of contact, connectedness, closeness and relationship satisfaction through the online survey. This finding supports media multiplexity theory. According to media multiplexity theory (MMT), people in weak ties (e.g., acquaintances, casual contacts) use one or a maximum of two media and people in strong ties (e.g., close family and friends) use two or more media to connect to one another (Haythornthwaite, 2005b). This further suggests that the addition of media is likely to be beneficial for the relationship as it is likely to increase connectedness and closeness in a relationship.

All three of the studies indicated that people use different media to connect to one another and it depends on their perceived ease of use, convenience, monitory costs, technology savviness and the need that media satisfies at that time for that particular purpose. For example, to send a quick message a person in a hurry may prefer an instant message application whereas to talk in detail about an issue or a topic, a person may prefer to call, or to send an itinerary for an upcoming family holiday, a person may send an email. From all three studies, it was found that people had one main preferred media that was used for most of the communication with other media used less frequently depending on the need. This is line with findings by Dainton and Aylor (2002), who reported similar findings for long distance romantic couples.

Findings of the *SmartLamp* and the *ConnectJewellery* studies showed that the most popular technologies used to keep in touch were instant messaging apps such as WhatsApp or Facebook messenger to send texts, share photos and to keep frequent contact as it was fast, convenient and less costly. Many participants mentioned talking on the phone (including instant messenger calls, landline or mobile phone calls) however this was less frequent yet for a longer duration. Some participants mentioned using emails, however, this was less frequent and only for formal, work purpose. Some also used Video chat which was similar to telephone calls in that they were less frequent but for a longer duration. Some of the other media used included Snapchat, Family IM chats, SMS, social media and online games. Similar to these, the findings of the online survey showed that top four ICT reported by adult children to contact parents are mobile phone calls, instant messengers, text messaging (SMS) and audio-video calls via Skype/FaceTime and the top four ICT used by parents to contact their adult children are text messaging (SMS), mobile calling, instant messaging and emails. Previous studies have found mobile phones and SMS as two of the main ICT used for maintaining a relationship over the distance with their parents (Ramsey et al., 2013; Schon, 2014; Tee et al., 2009). This could reflect the fast-changing landscape of ICT use (Madden et al., 2010). Indeed, previous studies

which report emails and SMS as second popular media choices, also reporting a decrease in email use between adult children and their parents (Ramsey et al., 2013). This suggests that while designing new technologies, designers need to acknowledge the type of technologies used are constantly changing.

6.5 Design facets for future designs

The evaluation and findings of all three studies, inform six key affective design facets that future designers and researchers could use to design technologies to support connectedness for parent-adult child relationships. Additionally, learning from the evaluations of *SmartLamp* (Chapter 3) and *ConnectJewellery* (Chapter 5), we also suggest seven practical design implications.

6.5.1 Affective design implications

1. **Emotional connection-** Findings of all studies provided strong evidence that both adult children and their parents desire a sense of connectedness and artefacts that allow for exchanges of affective messages as well as awareness of other people are meaningful to this relationship in providing emotional support.
2. **Reassurance**- Findings of all three studies indicated a strong need for reassurance for parents as well as adult children. The need for reassurance of adult children's physical safety for parents of young adults seem to be greater however as the parent get older the adult children seem to worry about the parent's health (physical) safety. Both parent and adult children also worry about emotional wellbeing of each other. Therefore, artefacts that allow peace of mind by providing reassurance about emotional and health wellbeing could be beneficial.
3. **Synchronicity-** Findings of the *SmartLamp* and *ConnectJewellery* indicated that immediately received signals provided the awareness of the person in real time which was facilitated by synchronous technologies. The synchronous exchanges of signals provide opportunities for parents to follow their adult children's life, awareness of the routine to passively keep each other updated and feeling being part of their lives. Both the lamp and the jewellery in some form supported awareness of the routine of the lives of each other suggesting the synchronous medium could be beneficial.
4. **Exclusivity-** A dedicated object that is exclusive between the dyad is more meaningful to support connectedness rather than traditional communication technologies that are used with many people. We found that in some cases these artefacts could become a representation or proxy of the distant loved ones.
5. **Reduced obligation for reciprocity**: Adult children reported feeling guilty for not communicating enough with their parents or not being available for their parents as they think that they are not meeting their parent's expectations. Parents also do not want to burden their adult children with an obligation to reply right away however they do desire more contact and may

feel neglected if they do not receive a reply from their adult children. Designing technologies that can cater for this need could be beneficial for this relationship to maintain connectedness and reduce the guilty feelings of adult children and also provide parents with the feeling that they are not disturbing their adult children.

6. **Lower threat to privacy**: There can be three types of threat to privacy issues with communication technologies. Firstly, the privacy concern of sharing certain information with the other communication partner which a person may not want to share. Secondly, concerns over being in an environment where others may overhear or see the private communication. Thirdly, concerns that you might be invading your partner's privacy by knowing something about them. Artefact that account for or lessen all these privacy concerns will be ideal to support parent-adult children relationships. In the *SmartLamp* study (Chapter 3) it was found that it might be especially difficult to account for this issue when designing awareness systems as providing awareness information about an activity requires some form of self-discourse, yet privacy is desired as well. Expressive systems might be a better solution as this was not experienced in jewellery study (Chapter 5).

6.5.2 Practical design implications

1. **Artefacts that are physical in nature:** The findings of Study 1 and study 3 provide strong evidence that the physical artefacts may be more meaningful to create connection rather than mobile apps or computer websites. Comparison of *ConnectJewellery* and *ConnectText* (see Chapter 5) provided strong evidence that screen-based technologies need the focused attention of their user, therefore, artefacts that does not demand focused attention will be better at supporting connectedness. This was also found in the evaluation of *SmartLamp* (see Chapter 3) which was an awareness system placed in a user's surrounding. This is also supported by previous literature. Pedersen (1998) and Wisneski et al. (1998) noted that users could notice peripheral information and the awareness systems should leverage more of our peripheral awareness than demand our focused attention that screen-based technologies may require.
2. **Aesthetically pleasing, personalised design:** The participants preferred personalised, beautiful designs and small artefacts. For example, most participants wanted the jewellery to be small and have it fitted to their finger or wrist size. Some of the male participants from the jewellery study (see Chapter 5) said that they would not normally wear jewellery and would rather use a bracelet that is either gender neutral or designs that would suit their style, for example, a watch. At the same time, most female participants loved the design of the jewellery, and some of the reasons were that the design suited their style and some of them owned other jewellery that matched the ring or the bracelet. This is also supported by previous literature. Dey and de

Guzman (2006) stated the importance of small artefacts that provide an obvious connection between distant pairs. Additionally, users prefer artefacts that they can control the use of. For example, in the *SmartLamp* study (see Chapter 3), the parent was able to turn the lamp off, and son/daughter could disable the trigger of the lamp to stop sending signals. Also, for the *ConnectJewellery* study (see Chapter 5), participants could disable the light feature or change the vibrations from a single buzz to four buzzes. They could also easily change the context of messages to give it a personal touch rather than a generic message.

3. **Non-intrusive yet noticeable for the intended user:** Participants mentioned that they liked designs that are non-intrusive or unobtrusive. *SmartLamp* (Chapter 3) were small in size and were part of the furniture therefore overall were less obtrusive. They were placed in visible location in a house, such as the living room, therefore were easily noticeable. For the jewellery (Chapter 5), which was a wearable artefact, it was easier to achieve non-intrusiveness as the vibrations were strong enough to be noticed/felt but not too strong to attract the attention of the others around.
4. **Effortless, easy to use and to set up:** Findings of the all three studies in this thesis suggest that it was of extreme importance that the systems were easy to set up and easy to use. This is especially important in the case of non-technologically savvy users and busy people. The ease of setting up of communication technology is important and although designers/company might provide detailed instruction of the device/technology setup, the intuitiveness of the setup is paramount for users to feel confident to use it. The automated systems similar to *SmartLamp* could be of value for busy people to create the presence of the distant loved one. All three studies suggest that the popular media used by participants as well as one of the reasons for liking the *SmartLamp* and *ConnectJewellery* was that it was perceived as easy to use. Although it might be given that easy to use media which is less effortful is the best way to design, some researchers argue that difficult interactions might be more meaningful for a close interpersonal relationship as they require more effort and therefore are could convey the feeling of care more effectively (Kelly et al., 2016). Although this might be true in some instances, the effortful media is less likely to be frequently used and therefore might not be suitable to support connectedness. All three studies in this thesis demonstrate that the technologies that demand least effort are more popularly used.
5. **Reliable:** The findings of all three studies provided evidence that the media used to communicate was often chosen based on how reliable it was to send-receive messages. The dependency of the IoT on the internet or Wi-Fi connection can greatly hamper its reliability. Temperamental artefacts also hamper the user experience and also give rise to frustration.
6. **Consume less power or longer battery use**: It is important that the technologies have overall less monitory costs (including technology cost and

cost of use such as energy and network provider costs). One of the important factors that were found in the evaluation of *ConnectJewellery* (see Chapter 5) and *SmartLamp* (see Chapter 3) was the dependency on energy which is a major factor holding back IoT technologies. The artefact designed needs to be environment-friendly and consume less power. Especially, if they are to be kept on for a longer period of time. The need to charge the battery frequently (e.g. smart jewellery) or the continuous consumption of energy (e.g. lamp) are some of the main practical factors that have to be considered while designing these artefacts.

7. **Waterproof**: It is important that the artefacts are waterproof, especially if they are wearable devices, artefacts placed in outdoor surroundings or likely to be in contact with water. The smart jewellery mentioned in Chapter 5 was water resistant, however, participants did not feel comfortable letting it get in contact with any water as they feared they might damage it. Therefore, they had to take it off in the shower, while exercising or if it was raining. This has an effect on their overall interaction experience as they might not use it in the countries such as the UK where it often rains.

6.6 The strength of this work

The literature review revealed that very few designers or researchers in HCI that proposed novel designs to connect close relationship evaluated their artefacts. Out of the ones that did carry out some evaluations, very few conducted longitudinal field studies, and these were with only a few participants; typically only four pairs for longitudinal studies and 16 participants for lab studies (Hassenzahl et al., 2012). Also, few studies focus on the needs of the specific relationships and have aimed at general "close interpersonal relationships" including lovers, friends, families, however, needs of lovers can be very different to needs of parent-adult children relationship. This thesis carried out two longitudinal field studies by employing six pairs and nine pairs of dyads respectively. The online survey study had over 800 number of total participants which was another strength, therefore, the findings can be generalised. The artefacts designed were informed by previous research in psychology as well as HCI studies.

Additionally, the literature review indicated that most evaluations carried out were qualitative. This could be because capturing nuances of experiences with artefacts can be difficult with only quantitative data. Very few use a mixed method approach. The ones that use mixed methods do not employ validated questionnaires and the few that do, do not analyse data using statistics, e.g. Forghani et al. (2014) collect some quantitative data yet it is presented in a graph without numbers or without any statistical analysis. Also, there is a lack of validated questionnaires to evaluate such communication technologies. This has also been acknowledged by other researchers and some attempts to create validated questionnaire have been made (Yarosh et al., 2014). Also, this thesis employed validated measures of closeness, social presence,

and relationship satisfaction and where measures were not validated (connectedness, the frequency of contact), the reliability of this measure was reported.

The literature review also revealed that not many parent-adult children studies carried out in psychology employ dyads, neither do they do studies on an unrelated parent or adult children. Most studies are carried out on either parent or adult child and also focus on a particular age group such as college students or old parents that need care. This thesis employed dyads in two studies and in one study collected data from unrelated parents and adult children.

6.7 Limitations and future work

The two devices presented in Chapter 3 and Chapter 5 were evaluated over a reasonable length of time (four to six weeks). However it should be noted that this cannot be considered `long-term' within the context of a parent-adult child relationship. This was because there would be a compromise on the number of participants due to limited resources. For example, the Ringly jewellery used in the *ConnectJewellery* study are actual jewellery pieces that use semi-precious stones and gold plating with sophisticated technology inside and were very expansive (approximately £200 per piece including international tax and shipping charges) hence we could only purchase a few of them. Also, we had limited sizes and needed to consider our participant's finger and wrist size. This meant that at a time we could run studies with only two dyads at the most.

Another reason was increasing the length of the study affects recruitment as people would be less willing to make a longer commitment and increases the chances of participant drop out, affecting the study. Additionally, most past studies do not conduct an evaluation in the wild and only carry out pilot studies. The ones that do employ a more involved evaluation process on the average spend 1-2 weeks, and a very few have carried out 4 or more weeks. To keep the number of participants reasonably high as well as keeping the duration long enough to collect enough data to meaningfully evaluate the artefact, we believed that four to six weeks of the evaluation was a justifiable length of the studies. However, as an element of further work, the idea of running evaluations of these devices over the course of several months could be beneficial. It would allow us to reflect on two areas which our work cannot. The first of these is how dyads' use of the devices changes as the novelty effect of having the device is mitigated over time. The second is to understand better whether the repeated positive sense of connection engendered when the device is being used contributes to a longer-term sense of connection which supports the dyad more generally.

One of the main limitations that all three studies suffer from self-selection bias. All three studies of this thesis had more female participants. Especially the user experience evaluation in Chapter 3 and Chapter 5, out of all 30 participants, 26 were

females, one was a father, and 3 were sons. All three studies had most enthusiastic responses from all the female participants. They were very willing to explore ways to connect more with their adult children or mothers. It was a struggle to recruit males and especially fathers to participate in our study, this is not to say that they were not willing, but given the option, adult children chose to do the studies with their mothers. Females enthusiasm could be because female naturally might be more interested in the maintenance of a close relationship. This could be further explained by one of our own findings from online survey (Chapter 4) and *ConnectJewellery* (Chapter 5) that males are generally less communicative and are more practical in conversation whereas females are more communicative more affectionate and emotional. Future work could look at a deeper investigation to pinpoint specific design factors that would be amenable to fostering meaningful experiences of connection between fathers and their adult children to propose designs to support father-adult children.

This thesis also found that the father's desired connectedness is higher than their actual connectedness and adult children desire more connectedness with their fathers. This suggests there is merit in developing technologies that help close that gap between desired and actual connectedness for fathers and their adult children. As this thesis had demonstrated the success of using phatic communication to maintain relationships, phatic communication aimed at fathers could be successful. This thesis found through qualitative findings that adult children tend to have a more playful "banterful" relationship with their father. The study of technologies that focus on allowing fathers to play games with their children or allow playful interaction over a distance that maintains contact without necessarily exchanging information would be an interesting avenue of research.

The findings of the *SmartLamp* (see Chapter 3) and *ConnectJewelley* (see Chapter 5) studies provide with design implications discussed in section 3.6 and section 5.4. As an element of future work, we would like to arrange a participatory design thinking workshop with IoT designers and researcher of HCI field along with pairs of parents and their adult children to design novel ideas of IoT technologies to support different types of parent-adult child relationships. The summary of the findings of this thesis along with the design implications could be presented to them which could inform and inspire novel ideas of IoT technologies that could support parent-adult child relationships. The prototypes of these designs could be then iteratively developed and evaluated with parents and adult children over a period of time.

The review of the literature also indicated the scarcity of the technologies designed for parent-adult children relationships. This thesis provides evidence that awareness and expressiveness strategies could be meaningful in supporting parent-adult child relationships. The findings from Chapter 4 indicate that this relationship might also benefit from technologies that allow a joint action to perform doing things together. Some participants mentioned the possibility of using virtual reality. It can be

suggested that exploring a joint action strategy using virtual reality would possibly support parent-adult child relationship.

6.8 Conclusion

This thesis offers empirical, theoretical as well as practical contributions to the understanding of parent-adult children communication studies. The empirical contribution is an exploration of the design space for interactive technologies that can support social presence, connectedness, and closeness between parents and adult children. This thesis produced a list of design implications that can be used by designers and researchers when designing technologies to support distant parents and adult children, or to support connectedness and closeness in geographically distant yet emotionally close interpersonal relationships. This research also offers a theoretical contribution by better understanding the current communication practices and value of connectedness to the relationships between parents and their adult children. Finally, this thesis offers a practical contribution that new modalities that conveys a simple one bit of information can enhance parents' relationships with their adult children.

7 References

Adcock, M., Boch, M., Harden, V., Harry, D., & Poblano, R. (2007). Tug n'talk: A belt buckle for tangible tugging communication. *alt. chi 2007*.

Akram, R. N., Chen, H.-H., Lopez, J., Sauveron, D., & Yang, L. T. (2018). Security, privacy and trust of user-centric solutions. In: Elsevier.

Aldous, J. (1987). New views on the family life of the elderly and the near-elderly. *Journal of Marriage and the Family*, 227-234.

Altman, I., & Taylor, D. A. (1973). *Social penetration: The development of interpersonal relationships*: Holt, Rinehart & Winston.

Amato, P. R., & Booth, A. (1991). Consequences of parental divorce and marital unhappiness for adult well-being. *Social Forces, 69*(3), 895-914.

Angelini, L., Caon, M., Lalanne, D., Khaled, O. A., & Mugellini, E. (2014). *Hugginess: encouraging interpersonal touch through smart clothes*. Paper presented at the Proceedings of the 2014 ACM International Symposium on Wearable Computers: Adjunct Program, Seattle, Washington.

Antonucci, T. C. (2001). Social relations an examination of social networks, social support. *Handbook of the psychology of aging, 3*, 427.

Aquilino, W. S. (1994). Impact of childhood family disruption on young adults' relationships with parents. *Journal of Marriage and the Family*, 295-313.

Aquilino, W. S. (2005). Impact of family structure on parental attitudes toward the economic support of adult children over the transition to adulthood. *Journal of Family Issues, 26*(2), 143-167.

Arafsha, F., Alam, K. M., & El Saddik, A. (2012). *EmoJacket: Consumer centric wearable affective jacket to enhance emotional immersion.* Paper presented at the Innovations in Information Technology (IIT), 2012 International Conference on.

Aron, A., Aron, E. N., & Smollan, D. (1992). Inclusion of Other in the Self Scale and the structure of interpersonal closeness. *Journal of personality and social psychology, 63*(4), 596.

Ashbrook, D., Baudisch, P., & White, S. (2011). *Nenya: subtle and eyes-free mobile input with a magnetically-tracked finger ring.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Ashkanasy, S., Benda, P., & Vetere, F. (2007). *Happy coincidences in designing for social connectedness and play through opportunistic image capture.* Paper presented at the Proceedings of the 2007 conference on Designing for User eXperiences.

Ashton, K. (2009). That 'Internet of Things' Thing. Retrieved from http://www.rfidjournal.com/articles/view?4986

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer networks, 54*(15), 2787-2805.

Baharin, H., Nor, R. M., & Mühlberger, R. (2008). *It's the thought that counts: Content vs. Contact.* Paper presented at the Proceedings of the 20th Australasian Conference on Computer-Human Interaction: Designing for Habitus and Habitat.

Bailey, B. P., & Konstan, J. A. (2006). On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior, 22*(4), 685-708.

Bales, Li, K. A., & Griwsold, W. (2011). *CoupleVIBE: mobile implicit communication to improve awareness for (long-distance) couples.* Paper presented at the Proceedings of the ACM 2011 conference on Computer supported cooperative work.

Ballagas, R., Borchers, J., Rohs, M., & Sheridan, J. G. (2006). The smart phone: a ubiquitous input device. *IEEE Pervasive Computing, 5*(1), 70-77.

Bandyopadhyay, D., & Sen, J. (2011). Internet of things: Applications and challenges in technology and standardization. *Wireless Personal Communications, 58*(1), 49-69.

Barber, C. E. (1989). Transition to the empty nest. *Aging and the family*, 15-32.

Barkhuus, L. (2007). Mobile Networked Text Communication: The Case of SMS and Its In? uence on Social Interaction. In *Designing for Networked Communications: Strategies and Development* (pp. 269-287): IGI Global.

Bassi, A., & Horn, G. (2008). Internet of Things in 2020: A Roadmap for the Future. *European Commission: Information Society and Media*.

Battarbee, K., Baerten, N., Hinfelaar, M., Irvine, P., Loeber, S., Munro, A., & Pederson, T. (2002). *Pools and satellites: intimacy in the city.* Paper presented at the Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques.

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: desire for interpersonal attachments as a fundamental human motivation. *Psychological bulletin, 117*(3), 497.

Beatty, M. J., & Dobos, J. A. (1992). Adult sons' satisfaction with their relationships with fathers and person-group (father) communication apprehension. *Communication Quarterly, 40*(2), 162-176.

Bedford, V. H., & Blieszner, R. (2000). Older adults and their families.

Ben-Ari, A., & Lavee, Y. (2007). Dyadic closeness in marriage: From the inside story to a conceptual model. *Journal of Social and Personal Relationships, 24*(5), 627-644.

Bengtson, V. L. (2001). Beyond the nuclear family: The increasing importance of multigenerational bonds. *Journal of Marriage and Family, 63*(1), 1-16.

Bengtson, V. L., & Kuypers, J. A. (1971). Generational difference and the developmental stake. *Aging and Human development, 2*(4), 249-260.

Bengtson, V. L., & Roberts, R. E. (1991). Intergenerational solidarity in aging families: An example of formal theory construction. *Journal of Marriage and the Family*, 856-870.

Bengtson, V. L., & Schrader, S. S. (1982). Parent-child relations. *Research instruments in social gerontology, 2*, 115-186.

Bentley, F. R., & Metcalf, C. J. (2007). *Sharing motion information with close family and friends.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Bergstrom, T., & Karahalios, K. (2006). *Communicating more than nothing.* Paper presented at the CHI'06 Extended Abstracts on Human Factors in Computing Systems.

Berscheid, E., Snyder, M., & Omoto, A. M. (1989). The Relationship Closeness Inventory: Assessing the closeness of interpersonal relationships. *Journal of personality and social psychology, 57*(5), 792.

Berscheid, E., Snyder, M., & Omoto, A. M. (2004). Measuring closeness: The relationship closeness inventory (RCI) revisited. *Handbook of closeness and intimacy*, 81-101.

Berzowska, J., & Coelho, M. (2006). *Smoks: the memory suits.* Paper presented at the CHI'06 Extended Abstracts on Human Factors in Computing Systems.

Beutel, A. M., & Marini, M. M. (1995). Gender and values. *American sociological review*, 436-448.

Bhandari, S., & Bardzell, S. (2008). *Bridging gaps: affective communication in long distance relationships.* Paper presented at the CHI'08 extended abstracts on Human factors in computing systems.

Biocca, F., & Harms, C. (2002). Defining and measuring social presence: Contribution to the networked minds theory and measure. *Proceedings of PRESENCE, 2002*, 1-36.

Biocca, F., Harms, C., & Burgoon, J. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence, 12*(5), 456-480.

Biocca, F., Harms, C., & Gregg, J. (2001). *The networked minds measure of social presence: Pilot test of the factor structure and concurrent validity.* Paper presented at the 4th annual International Workshop on Presence, Philadelphia, PA.

Birditt, K. S., Miller, L. M., Fingerman, K. L., & Lefkowitz, E. S. (2009). Tensions in the parent and adult child relationship: Links to solidarity and ambivalence. *Psychology and aging, 24*(2), 287.

Bonanni, L., Vaucelle, C., Lieberman, J., & Zuckerman, O. (2006). *TapTap: a haptic wearable for asynchronous distributed touch therapy.* Paper presented at the CHI'06 extended abstracts on Human factors in computing systems.

Boneva, B., Kraut, R., & Frohlich, D. (2001). Using e-mail for personal relationships: The difference gender makes. *American behavioral scientist, 45*(3), 530-549.

Braun, V., Clarke, V., & Terry, G. (2014). Thematic analysis. *Qual Res Clin Health Psychol*, 95-114.

Brave, S., & Dahley, A. (1997). *inTouch: a medium for haptic interpersonal communication.* Paper presented at the CHI'97 Extended Abstracts on Human Factors in Computing Systems.

Brewer, M. B., & Gardner, W. (1996). Who is this" We"? Levels of collective identity and self representations. *Journal of personality and social psychology, 71*(1), 83.

Brush, A., Inkpen, K. M., & Tee, K. (2008). *SPARCS: exploring sharing suggestions to enhance family connectedness.* Paper presented at the Proceedings of the 2008 ACM conference on Computer supported cooperative work.

Buchenau, M., & Suri, J. F. (2000). *Experience prototyping.* Paper presented at the Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques.

Bucx, F., Van Wel, F., Knijn, T., & Hagendoorn, L. (2008). Intergenerational contact and the life course status of young adult children. *Journal of Marriage and Family, 70*(1), 144-156.

Buxton, W. (1992). *Telepresence: Integrating shared task and person spaces.* Paper presented at the Proceedings of graphics interface.

Canary, D. J., Stafford, L., Hause, K. S., & Wallace, L. A. (1993). An inductive analysis of relational maintenance strategies: Comparisons among lovers, relatives, friends, and others. *Communication Research Reports, 10*(1), 3-14.

Cao, X., Sellen, A., Brush, A., Kirk, D., Edge, D., & Ding, X. (2010). *Understanding family communication across time zones.* Paper presented at the Proceedings of the 2010 ACM conference on Computer supported cooperative work.

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: support for socioemotional selectivity theory. *Psychology and aging, 7*(3), 331.

Carvalho, J., Francisco, R., & Relvas, A. P. (2015). Family functioning and information and communication technologies: How do they relate? A literature review. *Computers in Human Behavior, 45*, 99-108.

Castells, M. (2011). *The rise of the network society: The information age: Economy, society, and culture* (Vol. 1): John Wiley & Sons.

Cha, J., Eid, M., Barghout, A., Rahman, A., & El Saddik, A. (2009). *HugMe: synchronous haptic teleconferencing.* Paper presented at the Proceedings of the 17th ACM international conference on Multimedia.

Chai, M. Z., Soro, A., Roe, P., & Brereton, M. (2017). *Cooking Together at a Distance: Sustain Connectedness for Long Distance Families.* Paper presented at the Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems.

Chang, A., O'Modhrain, S., Jacob, R., Gunther, E., & Ishii, H. (2002). *ComTouch: design of a vibrotactile communication device.* Paper presented at the Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques.

Chang, A., Resner, B., Koerner, B., Wang, X., & Ishii, H. (2001). *LumiTouch: an emotional communication device.* Paper presented at the CHI'01 extended abstracts on Human factors in computing systems.

Chayko, M. (2008). *Portable communities: The social dynamics of online and mobile connectedness*: Suny Press.

Chen, Forlizzi, J., & Jennings, P. (2006). *ComSlipper: an expressive design to support awareness and availability.* Paper presented at the CHI'06 Extended Abstracts on Human Factors in Computing Systems.

Chen, & Katz. (2009). Extending family to school life: College students' use of the mobile phone. *International Journal of Human-Computer Studies, 67*(2), 179-191.

Chung, H., Lee, C.-H. J., & Selker, T. (2006). *Lover's cups: drinking interfaces as new communication channels.* Paper presented at the CHI'06 extended abstracts on Human factors in computing systems.

Clark, M. S., Fitnessand, J., & Brissette, I. (2001). Understanding people's perceptions of relationships is crucial to understanding their emotional lives. *Blackwell handbook of social psychology: Interpersonal processes*, 250-278.

Cochran, W. G. (1954). Some methods for strengthening the common χ 2 tests. *Biometrics, 10*(4), 417-451.

Cohen, & Crabtree, B. (2006). Qualitative research guidelines project. In.

Cohen, S. (2004). Social relationships and health. *American Psychologist, 59*(8), 676.

Collins, N. L., & Read, S. J. (1990). Adult attachment, working models, and relationship quality in dating couples. *Journal of personality and social psychology, 58*(4), 644.

Connidis, I. A., & McMullin, J. A. (2002). Sociological ambivalence and family ties: A critical perspective. *Journal of Marriage and Family, 64*(3), 558-567.

Consolvo, S., Roessler, P., & Shelton, B. E. (2004, 2004//). *The CareNet Display: Lessons Learned from an In Home Evaluation of an Ambient Display.* Paper presented at the UbiComp 2004: Ubiquitous Computing, Berlin, Heidelberg.

Correa, T., Hinsley, A. W., & De Zuniga, H. G. (2010). Who interacts on the Web?: The intersection of users' personality and social media use. *Computers in Human Behavior, 26*(2), 247-253.

Counts, S., & Fellheimer, E. (2004). *Supporting social presence through lightweight photo sharing on and off the desktop.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Crang, M., Crosbie, T., & Graham, S. (2007). Technology, time–space, and the remediation of neighbourhood life. *Environment and planning A, 39*(10), 2405-2422.

Czerwinski, M., Cutrell, E., & Horvitz, E. (2000a). *Instant messaging and interruption: Influence of task type on performance.* Paper presented at the OZCHI 2000 conference proceedings.

Czerwinski, M., Cutrell, E., & Horvitz, E. (2000b). *Instant messaging: Effects of relevance and timing.* Paper presented at the People and computers XIV: Proceedings of HCI.

Dainton, M., & Aylor, B. (2002). Patterns of communication channel use in the maintenance of long-distance relationships. *Communication Research Reports, 19*(2), 118-129.

Dalsgaard, T., Skov, M. B., & Thomassen, B. R. (2007). *eKISS: sharing experiences in families through a picture blog.* Paper presented at the Proceedings of the 21st British HCI Group Annual Conference on People and Computers: HCI... but not as we know it-Volume 1.

Davis, Hu, J., Feijs, L., & Owusu, E. (2015). *Social hue: A subtle awareness system for connecting the elderly and their caregivers.* Paper presented at the Pervasive Computing and Communication Workshops (PerCom Workshops), 2015 IEEE International Conference on.

Davis, H., Vetere, F., Francis, P., Gibbs, M., & Howard, S. (2008). I wish we could get together": Exploring intergenerational play across a distance via a 'Magic Box. *Journal of intergenerational relationships, 6*(2), 191-210.

De Greef, P., & IJsselsteijn, W. (2000). Social presence in the PhotoShare tele-application. *Proceedings of PRESENCE*, 27-28.

Derlaga, V. J., & Berg, J. H. (1987). *Self-disclosure: Theory, research, and therapy*: Springer Science & Business Media.

Dey, A. K., & de Guzman, E. (2006). *From awareness to connectedness: the design and deployment of presence displays.* Paper presented at the Proceedings of the SIGCHI conference on human factors in computing systems.

Dibble, J. L., Levine, T. R., & Park, H. S. (2012). The Unidimensional Relationship Closeness Scale (URCS): reliability and validity evidence for a new measure of relationship closeness. *Psychological assessment, 24*(3), 565.

Dimmick, J., Kline, S., & Stafford, L. (2000). The gratification niches of personal e-mail and the telephone competition, displacement, and complementarity. *Communication Research, 27*(2), 227-248.

Dobson, K., Ju, W., Donath, J., & Ishii, H. (2001). *Creating visceral personal and social interactions in mediated spaces.* Paper presented at the CHI'01 Extended Abstracts on Human Factors in Computing Systems.

Dodge, C. (1997). *The bed: a medium for intimate communication.* Paper presented at the CHI'97 Extended Abstracts on Human Factors in Computing Systems.

Dourish, P., & Bellotti, V. (1992). *Awareness and coordination in shared workspaces*. Paper presented at the Proceedings of the 1992 ACM conference on Computer-supported cooperative work, Toronto, Ontario, Canada. http://delivery.acm.org/10.1145/150000/143468/p107-dourish.pdf?ip=138.38.82.253&id=143468&acc=ACTIVE%20SERVICE&key=BF07A2EE685417C5%2E85B475708465C551%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1517950948_89d15b668df8326274cedbb17b99b586

Duggan, M., Lenhart, A., Lampe, C., & Ellison, N. B. (2015). Parents and social media. *Pew Research Center*, 1-37.

Dunleavy, K. N., Wanzer, M. B., Krezmien, E., & Ruppel, K. (2011). Daughters' perceptions of communication with their fathers: the role of skill similarity and co-orientation in relationship satisfaction. *Communication Studies, 62*(5), 581-596.

Dunne, A., & Raby, F. (1994). Fields and thresholds. *Proceedings of the Doors of Perception-2*.

Dykstra, P., van den Broek, T., Muresan, C., Haragus, M., Haragus, P.-T., Abramowska-Kmon, A., & Kotowska, I. (2014). State-of-the-art report: Intergenerational linkages in families.

Eggebeen, D. J., & Hogan, D. P. (1990). Giving between generations in American families. *Human nature, 1*(3), 211-232.

Elder, G. H. (1998). The life course as developmental theory. *Child development, 69*(1), 1-12.

Elliot, K., & Greenberg, S. (2004). Building flexible displays for awareness and interaction.

End, C. M., Worthman, S., Mathews, M. B., & Wetterau, K. (2009). Costly cell phones: The impact of cell phone rings on academic performance. *Teaching of Psychology, 37*(1), 55-57.

Ermisch, J., Jantti, M., & Smeeding, T. M. (2012). *From parents to children: The intergenerational transmission of advantage*: Russell Sage Foundation.

Faulkner, X., & Culwin, F. (2004). When fingers do the talking: a study of text messaging. *Interacting with computers, 17*(2), 167-185.

Fehr, B. (2000). The life cycle of friendship. *Close relationships: A sourcebook*, 71-82.

Feltham, F., Vetere, F., & Wensveen, S. (2007). *Designing tangible artefacts for playful interactions and dialogues.* Paper presented at the Proceedings of the 2007 conference on Designing pleasurable products and interfaces.

Filimin. (2017). Long Distance Friendship Lamp.

Fingerman. (2000). " We Had a Nice Little Chat" Age and Generational Differences in Mothers' and Daughters' Descriptions of Enjoyable Visits. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 55*(2), P95-P106.

Fingerman, Cheng, Y.-P., Tighe, L., Birditt, K. S., & Zarit, S. (2012). Relationships between young adults and their parents. In *Early adulthood in a family context* (pp. 59-85): Springer.

Fingerman, Kim, K., Birditt, K., & Zarit, S. (2016). The ties that bind: Midlife parents' daily experiences with grown children. *Journal of Marriage and Family, 78*(2), 431-450.

Fingerman, Miller, L., Birditt, K., & Zarit, S. (2009). Giving to the good and the needy: Parental support of grown children. *Journal of Marriage and Family, 71*(5), 1220-1233.

Firmin, M. W., Firmin, R. L., & Lorenzen, K. M. (2006). Loneliness Dynamics Involved with College Long-Distance Relationships.

Fogg, B., Cutler, L. D., Arnold, P., & Eisbach, C. (1998). *HandJive: a device for interpersonal haptic entertainment.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Forghani, A., Venolia, G., & Inkpen, K. (2014). *Media2gether: Sharing media during a call.* Paper presented at the Proceedings of the 18th International Conference on Supporting Group Work.

Fors, S., & Lennartsson, C. (2008). Social mobility, geographical proximity and intergenerational family contact in Sweden. *Ageing & Society, 28*(2), 253-270.

Frei, A., & Axhausen, K. (2009). Modelling the frequency of contacts in a shrunken world. *Soc Netw (submitted)*.

Furstenberg, F. F., & Cherlin, A. J. (1991). *Divided families: What happens to children when parents part* (Vol. 1): Harvard University Press.

Gächter, S., Starmer, C., & Tufano, F. (2015). Measuring the closeness of relationships: a comprehensive evaluation of the'inclusion of the other in the self'scale. *PloS one, 10*(6), e0129478.

Gartner (Producer). (2014). Internet of Things. *http://www.gartner.com/*. Retrieved from http://www.gartner.com/it-glossary/internet-of-things/

Gaver, B. (2002). Provocative awareness. *Computer Supported Cooperative Work (CSCW), 11*(3-4), 475-493.

Gemperle, F., DiSalvo, C., Forlizzi, J., & Yonkers, W. (2003). *The Hug: a new form for communication.* Paper presented at the Proceedings of the 2003 conference on Designing for user experiences.

Gentzler, A. L., Oberhauser, A. M., Westerman, D., & Nadorff, D. K. (2011). College students' use of electronic communication with parents: links to loneliness, attachment, and relationship quality. *Cyberpsychology, Behavior, and Social Networking, 14*(1-2), 71-74.

Geser, H. (2005). Is the cell phone undermining the social order. *Thumb culture, 25*.

Gibbs, M. R., Vetere, F., Bunyan, M., & Howard, S. (2005). *SynchroMate: a phatic technology for mediating intimacy*. Paper presented at the Proceedings of the 2005 conference on Designing for User eXperience, San Francisco, California, USA.

Goldscheider, F. (1997). Recent changes in US young adult living arrangements in comparative perspective. *Journal of Family Issues, 18*(6), 708-724.

Golish, T. D. (2000). Changes in closeness between adult children and their parents: A turning point analysis. *Communication Reports, 13*(2), 79-97.

Gooch, D., & Watts, L. (2010). Communicating social presence through thermal hugs. *SISSI2010*, 11.

Gooch, D., & Watts, L. (2011a). *The magic sock drawer project.* Paper presented at the CHI'11 Extended Abstracts on Human Factors in Computing Systems.

Gooch, D., & Watts, L. (2011b). *Up close and personal: social presence in mediated personal relationships.* Paper presented at the Proceedings of the 25th BCS Conference on Human-Computer Interaction.

Gooch, D., & Watts, L. (2012a). *sleepyWhispers: sharing goodnights within distant relationships.* Paper presented at the Adjunct proceedings of the 25th annual ACM symposium on User interface software and technology.

Gooch, D., & Watts, L. (2012b). *YourGloves, hothands and hotmits: devices to hold hands at a distance.* Paper presented at the Proceedings of the 25th annual ACM symposium on User interface software and technology.

Gooch, D., & Watts, L. (2014). Social Presence and the void in distant relationships: How do people use communication technologies to turn absence into fondness of the heart, rather than drifting out of mind? *AI & SOCIETY, 29*(4), 507-519. doi:10.1007/s00146-013-0492-9

Goodman, E., & Misilim, M. (2003). *The sensing beds.* Paper presented at the UbiComp 2003 Workshop.

GoodNightLamp. (2016). Share your presence and availability with your global friends and family in an easy and ambient way.

Granovetter, M. S. (1973). The Strength of Weak Ties. *American Journal of Sociology, 78*(6), 1360-1380. doi:10.1086/225469

Greenberg, S., & Kuzuoka, H. (1999). Using digital but physical surrogates to mediate awareness, communication and privacy in media spaces. *Personal Technologies, 3*(4), 182-198.

Grinberg, N., Kalyanaraman, S., Adamic, L. A., & Naaman, M. (2017). *Understanding Feedback Expectations on Facebook.* Paper presented at the Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing.

Grivas, K. (2006). Digital Selves: Devices for intimate communications between homes. *Personal and Ubiquitous Computing, 10*(2-3), 66-76.

Grundy, E. (2005). Reciprocity in relationships: socio-economic and health influences on intergenerational exchanges between Third Age parents and their adult children in Great Britain. *The British Journal of Sociology, 56*(2), 233-255.

Grundy, E., & Shelton, N. (2001). Contact between Adult Children and Their Parents in Great Britain 1986–99. *Environment and Planning A: Economy and Space, 33*(4), 685-697. doi:10.1068/a33165

Gunawardena, C. N., & Zittle, F. J. (1997). Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. *American journal of distance education, 11*(3), 8-26.

Hall, J. A., & Baym, N. K. (2012). Calling and texting (too much): Mobile maintenance expectations,(over) dependence, entrapment, and friendship satisfaction. *New Media & Society, 14*(2), 316-331.

Hank, K. (2007). Proximity and contacts between older parents and their children: A European comparison. *Journal of Marriage and Family, 69*(1), 157-173.

Hansson, R., & Skog, T. (2001). *The LoveBomb: Encouraging the communication of emotions in public spaces.* Paper presented at the CHI'01 extended abstracts on Human Factors in computing systems.

Harboe, G., Massey, N., Metcalf, C., Wheatley, D., & Romano, G. (2008). The uses of social television. *Computers in Entertainment (CIE), 6*(1), 8.

Hardill, I., & Olphert, C. W. (2012). Staying connected: Exploring mobile phone use amongst older adults in the UK. *Geoforum, 43*(6), 1306-1312.

Harkins, E. B. (1978). Effects of empty nest transition on self-report of psychological and physical well-being. *Journal of Marriage and the Family*, 549-556.

Hartsell, T. (2008). Who's talking online? A descriptive analysis of gender & online communication. In *Information Communication Technologies: Concepts, Methodologies, Tools, and Applications* (pp. 3529-3539): IGI Global.

Hassenzahl, M., Heidecker, S., Eckoldt, K., Diefenbach, S., & Hillmann, U. (2012). All you need is love: Current strategies of mediating intimate relationships through technology. *ACM Transactions on Computer-Human Interaction (TOCHI), 19*(4), 30.

Hauber, J., Regenbrecht, H., Hills, A., Cockburn, A., & Billinghurst, M. (2005). Social presence in two-and three-dimensional videoconferencing.

Hay, E. L., Fingerman, K. L., & Lefkowitz, E. S. (2007). The experience of worry in parent–adult child relationships. *Personal relationships, 14*(4), 605-622.

Hayashi, T., Agamanolis, S., & Karau, M. M. (2008). *a body-drawing communicator for distant partners.* Paper presented at the the Proceedings of SIGGRAPH International Conference on Computer Graphics and Interactive Techniques, Los Angeles, USA.

Haythornthwaite, C. (2000). Online personal networks: Size, composition and media use among distance learners. *New Media & Society, 2*(2), 195-226.

Haythornthwaite, C. (2002). Strong, weak, and latent ties and the impact of new media. *The information society, 18*(5), 385-401.

Haythornthwaite, C. (2005a). Social networks and Internet connectivity effects. *Information, Communication & Society, 8*(2), 125-147. doi:10.1080/13691180500146185

Haythornthwaite, C. (2005b). Social networks and Internet connectivity effects. *Information, Community & Society, 8*(2), 125-147.

Haythornthwaite, C., & Wellman, B. (1998). Work, friendship, and media use for information exchange in a networked organization. *Journal of the American society for information science, 49*(12), 1101-1114.

Heeter, C. (1992). Being there: The subjective experience of presence. *Presence: Teleoperators and virtual environments, 1*(2), 262-271.

Hemmeryckx-Deleersnijder, B., & Thorne, J. M. (2008). Awareness and conversational context-sharing to enrich TV-based communication. *Computers in Entertainment (CIE), 6*(1), 7.

Hendrick, C., & Hendrick, S. S. (1989). Research on love: Does it measure up? *Journal of personality and social psychology, 56*(5), 784.

Heuser, L., Nochta, Z., & Trunk. (2008). *ICT shaping the world: A scientific view*, London.

Hill, R. A., & Dunbar, R. I. (2003). Social network size in humans. *Human nature, 14*(1), 53-72.

Hindus, D., Mainwaring, S. D., Leduc, N., Hagström, A. E., & Bayley, O. (2001). *Casablanca: designing social communication devices for the home.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Hoefnagels, S., Geelhoed, E., Stappers, P. J., Hoeben, A., & van der Lugt, R. (2004). *Friction in scheduling and coordinating lives of families: designing from an interaction metaphor.* Paper presented at the Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques.

Hofer. (2008). The electronic tether: Parental regulation, self-regulation, and the role of technology in college transitions. *Journal of The First-Year Experience & Students in Transition, 20*(2), 9-24.

Hofer, & Moore, A. S. (2011). *The iConnected parent: Staying close to your kids in college (and beyond) while letting them grow up*: Simon and Schuster.

Hoffmann, C., Jumpertz, S., & Marquet, B. (2007). *On nurturing strong-tie distant relationships: from theory to prototype.* Paper presented at the CHI'07 Extended Abstracts on Human Factors in Computing Systems.

Horrigan, J. B. (2007). A typology of information and communication technology users.

Horvitz, E. C. M. C. E. (2001). *Notification, disruption, and memory: Effects of messaging interruptions on memory and performance.* Paper presented at the Human-computer Interaction: INTERACT'01: IFIP TC. 13 International Conference on Human-Comupter Interaction, 9th-13th July 2001, Tokyo, Japan.

House, J. S., Landis, K. R., & Umberson, D. (1988). Social relationships and health. *Science, 241*(4865), 540-545.

Howard, S., Kjeldskov, J., Skov, M. B., Garnæs, K., & Grünberger, O. (2006). *Negotiating presence-in-absence: contact, content and context.* Paper

presented at the Proceedings of the SIGCHI conference on Human Factors in computing systems.

Howard, S., Vetere, F., Gibbs, M., Kjeldskov, J., Pedell, S., Mecoles, K., . . . Murphy, J. (2004). Mediating Intimacy: digital kisses and cut and paste hugs. *Proceedings of BCSHCI2004, Leeds, UK*, 26-29.

Hudson, N. W., & Fraley, R. C. (2017). Adult attachment and perceptions of closeness. *Personal relationships, 24*(1), 17-26.

Huijnen, C. A., IJsselsteijn, W. A., Markopoulos, P., & de Ruyter, B. (2004). Social presence and group attraction: exploring the effects of awareness systems in the home. *Cognition, Technology & Work, 6*(1), 41-44.

Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., . . . Hansen, H. (2003). *Technology probes: inspiring design for and with families.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

IHS. (2018). Internet of Things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions). Retrieved 6 March 2018, from Statista https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/.

IJsselsteijn, W., & Riva, G. (2003). Being there: The experience of presence in mediated environments.

IJsselsteijn, W., van Baren, J., Markopoulos, P., Romero, N., & De Ruyter, B. (2009). Measuring affective benefits and costs of mediated awareness: Development and validation of the ABC-questionnaire. In *Awareness Systems* (pp. 473-488): Springer.

IJsselsteijn, W., van Baren, J., & van Lanen, F. (2003). Staying in touch: Social presence and connectedness through synchronous and asynchronous communication media. *Human-Computer Interaction: Theory and Practice (Part II), 2*(924), e928.

Ishii, H. (2008). *Tangible bits: beyond pixels.* Paper presented at the Proceedings of the 2nd international conference on Tangible and embedded interaction.

Ishii, H., & Ullmer, B. (1997). *Tangible bits: towards seamless interfaces between people, bits and atoms.* Paper presented at the Proceedings of the ACM SIGCHI Conference on Human factors in computing systems.

Ishii, H., Wisneski, C., Brave, S., Dahley, A., Gorbet, M., Ullmer, B., & Yarin, P. (1998). *ambientROOM: integrating ambient media with architectural space.* Paper presented at the CHI 98 conference summary on Human factors in computing systems.

Ishii, K. (2006). Implications of mobility: The uses of personal communication media in everyday life. *Journal of Communication, 56*(2), 346-365.

Itoh, Y., Miyajima, A., & Watanabe, T. (2002). *'TSUNAGARI'communication: fostering a feeling of connection between family members.* Paper presented at the CHI'02 extended abstracts on Human factors in computing systems.

ITU. (2017). Number of internet users worldwide from 2005 to 2017 (in millions). Retrieved 5 February 2018, from Statista - The Statistics Portal https://www.statista.com/statistics/273018/number-of-internet-users-worldwide/.

Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly, 24*(4), 602-611.

Jing, L., Cheng, Z., Zhou, Y., Wang, J., & Huang, T. (2013). *Magic Ring: a self-contained gesture input device on finger.* Paper presented at the Proceedings of the 12th International Conference on Mobile and Ubiquitous Multimedia.

Joinson, A. N. (2001). Self-disclosure in computer-mediated communication: The role of self-awareness and visual anonymity. *European journal of social psychology, 31*(2), 177-192.

Jung, H., & Connelly, K. (2007). *Exploring design concepts for sharing experiences through digital photography.* Paper presented at the Proceedings of the 2007 conference on Designing pleasurable products and interfaces.

Kafková, B. H. M. P. (2017). Frequency and Intensity of Contact between Ageing Parents and their Adult Children in the Czech Republic: Exploration of Selected Predictors. *Sociológia, 49*(6), 657-672.

Katsumoto, Y., Kanai, E., Kirillova, N., Higashi, K., Miura, H., Matsumoto, T., . . . Inakage, M. (2006). *InScene: a communication device which uses incenses.* Paper presented at the Proceedings of the 2006 ACM SIGCHI international conference on Advances in computer entertainment technology.

Katz, J. E., & Aakhus, M. (2002). *Perpetual contact: Mobile communication, private talk, public performance*: Cambridge University Press.

Kaufman, G., & Uhlenberg, P. (1998). Effects of life course transitions on the quality of relationships between adult children and their parents. *Journal of Marriage and the Family*, 924-938.

Kaye, J. J. (2006). *I just clicked to say I love you: rich evaluations of minimal communication.* Paper presented at the CHI'06 extended abstracts on human factors in computing systems.

Kaye, J. J., & Goulding, L. (2004). *Intimate objects.* Paper presented at the Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques.

Kaye, J. J., Levitt, M. K., Nevins, J., Golden, J., & Schmidt, V. (2005). *Communicating intimacy one bit at a time.* Paper presented at the CHI'05 extended abstracts on Human factors in computing systems.

Keller, I., van der Hoog, W., & Stappers, P. J. (2004). Gust of me: reconnecting mother and son. *Pervasive Computing, IEEE, 3*(1), 22-27. doi:10.1109/MPRV.2004.1269125

Kelley, H. H., Berscheid, E., Christensen, A., Harvey, J. H., Huston, T. L., Levinger, G., Peterson, D. R. (1983). *Close relationships*: Freeman New York.

Kelly, R., Gooch, D., Patil, B., & Watts, L. (2016). *Demanding by Design: Supporting Effortful Communication Practices in Close Personal Relationships.* Paper presented at the The 20th ACM Conference on Computer-Supported Cooperative Work and Social Computing.

Kelly, R., Gooch, D., Patil, B., & Watts, L. (2017). *Demanding by Design: Supporting Effortful Communication Practices in Close Personal Relationships*. Paper presented at the Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, Portland, Oregon, USA.

Kikin-Gil, R. (2006). BuddyBeads: techno-jewelry for non-verbal communication within teenager girls groups. *Personal and Ubiquitous Computing, 10*(2-3), 106-109.

Kim, S., Kientz, J. A., Patel, S. N., & Abowd, G. D. (2008). *Are you sleeping?: sharing portrayed sleeping status within a social network.* Paper presented at the Proceedings of the 2008 ACM conference on Computer supported cooperative work.

King, S., & Forlizzi, J. (2007). *Slow messaging: intimate communication for couples living at a distance.* Paper presented at the Proceedings of the 2007 conference on Designing pleasurable products and interfaces.

Kirk, D. S., Sellen, A., & Cao, X. (2010). *Home video communication: mediating'closeness'.* Paper presented at the Proceedings of the 2010 ACM conference on Computer supported cooperative work.

Kjeldskov, J., Gibbs, M., Vetere, F., Howard, S., Pedell, S., Mecoles, K., & Bunyan, M. (2004). Using cultural probes to explore mediated intimacy. *Australasian Journal of Information Systems, 11*(2).

Kjeldskov, J., Gibbs, M., Vetere, F., Howard, S., Pedell, S., Mecoles, K., & Bunyan, M. (2005). Using cultural probes to explore mediated intimacy. *Australasian Journal of Information Systems*.

Komter, A. E., & Vollebergh, W. A. (2002). Solidarity in Dutch families: family ties under strain? *Journal of Family Issues, 23*(2), 171-188.

Koreshoff, T. L., Robertson, T., & Leong, T. W. (2013). *Internet of things: a review of literature and products.* Paper presented at the Proceedings of the 25th Australian Computer-Human Interaction Conference: Augmentation, Application, Innovation, Collaboration.

Kranz, M., Paul Holleis, Albrecht Schmidt. (2010). Embedded Interaction, Interaction with Internet of Things. *IEEE Computer Society*.

Kubacka, K. E., Finkenauer, C., Rusbult, C. E., & Keijsers, L. (2011). Maintaining Close Relationships Gratitude as a Motivator and a Detector of Maintenance Behavior. *Personality and Social Psychology Bulletin, 37*(10), 1362-1375.

Kushlev, K., Proulx, J., & Dunn, E. W. (2016). *"Silence Your Phones": Smartphone Notifications Increase Inattention and Hyperactivity Symptoms*. Paper presented at the Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, Santa Clara, California, USA. http://delivery.acm.org/10.1145/2860000/2858359/p1011-kushlev.pdf?ip=138.38.82.253&id=2858359&acc=ACTIVE%20SERVICE&key=BF07A2EE685417C5%2E85B475708465C551%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1517951050_d9867a1d7f7d311e55d8ff9435d3a248

Kuwabara, K., Watanabe, T., Ohguro, T., Itoh, Y., & Maeda, Y. (2002). *Connectedness oriented communication: Fostering a sense of connectedness to augment social relationships.* Paper presented at the Applications and the Internet, 2002.(SAINT 2002). Proceedings. 2002 Symposium on.

Kwon, H., Koleva, B., Schnädelbach, H., & Benford, S. (2017). " It's not yet a gift": understanding digital gifting.

Lambourne, R., Feiz, K., & Rigot, B. (1997). *Social trends and product opportunities: Philips' Vision of the Future project.* Paper presented at the Proceedings of the ACM SIGCHI Conference on Human factors in computing systems.

Lawton, L., Silverstein, M., & Bengtson, V. (1994). Affection, social contact, and geographic distance between adult children and their parents. *Journal of Marriage and the Family*, 57-68.

Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction*: Morgan Kaufmann.

Leach, M. S., & Braithwaite, D. O. (1996). A binding tie: Supportive communication of family kinkeepers. *Journal of Applied Communication Research, 24*(3), 200-216. doi:10.1080/00909889609365451

Ledbetter, A. M. (2009). Patterns of media use and multiplexity: Associations with sex, geographic distance and friendship interdependence. *New Media & Society, 11*(7), 1187-1208.

Ledbetter, A. M., & Kuznekoff, J. H. (2012). More than a game: Friendship relational maintenance and attitudes toward Xbox LIVE communication. *Communication Research, 39*(2), 269-290.

Lee, & Robbins, S. B. (1995). Measuring belongingness: The social connectedness and the social assurance scales. *Journal of counseling psychology, 42*(2), 232.

Lee, G. R., Netzer, J. K., & Coward, R. T. (1994). Filial responsibility expectations and patterns of intergenerational assistance. *Journal of Marriage and the Family*, 559-565.

Levinger, G. K., & Snoek, J. D. (1972). *Attraction in relationship: A new look at interpersonal attraction*: General Learning Press.

Lewis, J., West, A., Roberts, J., & Noden, P. (2015). Parents' involvement and university students' independence. *Families, Relationships and Societies, 4*(3), 417-432.

Li, M., & Jianting, H. (2009). *Ambient environments for emotional physical communication.* Paper presented at the Proceedings of the 10th International Conference NZ Chapter of the ACM's Special Interest Group on Human-Computer Interaction.

Licoppe, C. (2004). 'Connected'presence: the emergence of a new repertoire for managing social relationships in a changing communication technoscape. *Environment and planning D: Society and space, 22*(1), 135-156.

Licoppe, C., & Smoreda, Z. (2005). Are social networks technologically embedded?: How networks are changing today with changes in communication technology. *Social networks, 27*(4), 317-335.

Lindley, S. E. (2012). Shades of lightweight: supporting cross-generational communication through home messaging. *Universal Access in the Information Society, 11*(1), 31-43.

Lindley, S. E., Harper, R., & Sellen, A. (2009). *Desiring to be in touch in a changing communications landscape: attitudes of older adults.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Ling, R. (2004). *The mobile connection: The cell phone's impact on society*: Elsevier.

Litwak, E. (1960). Geographic mobility and extended family cohesion. *American sociological review*, 385-394.

Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication, 3*(2), 0-0.

Lotan, G., & Croft, C. (2007). *Impulse.* Paper presented at the CHI'07 Extended Abstracts on Human Factors in Computing Systems.

Lottridge, D., Masson, N., & Mackay, W. (2009). *Sharing empty moments: design for remote couples.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Lüscher, K., & Pillemer, K. (1998). Intergenerational ambivalence: A new approach to the study of parent-child relations in later life. *Journal of Marriage and the Family*, 413-425.

Lye, D. N. (1996). Adult child–parent relationships. *Annual review of sociology*, 79-102.

Lye, D. N., Klepinger, D. H., Hyle, P. D., & Nelson, A. (1995). Childhood living arrangements and adult children's relations with their parents. *Demography, 32*(2), 261-280.

Madden, M., Lenhart, A., Cortesi, S., & Gasser, U. (2010). Pew Internet and American life project. *Washington, DC: Pew Research Center*.

Magai, C., & McFadden, S. H. (1996). *Handbook of emotion, adult development, and aging*: Elsevier.

Makice, K. (2009). *Phatics and the design of community.* Paper presented at the CHI'09 Extended Abstracts on Human Factors in Computing Systems.

Maltz, D. N., & Borker, R. A. (1982). A cultural approach to male-female miscommunication. *A cultural approach to interpersonal communication: Essential readings*, 168-185.

Mancini, J. A., & Blieszner, R. (1989). Aging parents and adult children: Research themes in intergenerational relations. *Journal of Marriage and the Family*, 275-290.

Markopoulos, P., IJsselsteijn, W., Huijnen, C., & De Ruyter, B. (2005). Sharing experiences through awareness systems in the home. *Interacting with computers, 17*(5), 506-521.

Markopoulos, P., IJsselsteijn, W., Huijnen, C., Romijn, O., & Philopoulos, A. (2003). Supporting relationships through awareness systems. *Being there: concepts, effects and measurements of user presence in synthetic environments. Emerging communication series, 5*, 261-278.

Markopoulos, P., Romero, N., van Baren, J., IJsselsteijn, W., de Ruyter, B., & Farshchian, B. (2004). *Keeping in touch with the family: home and away with the ASTRA awareness system.* Paper presented at the CHI'04 extended abstracts on Human factors in computing systems.

Marmasse, N., Schmandt, C., & Spectre, D. (2004). *WatchMe: communication and awareness between members of a closely-knit group.* Paper presented at the International Conference on Ubiquitous Computing.

Mashek, D. J., & Aron, A. (2004). *Handbook of closeness and intimacy*: Psychology Press.

Mattanah, J. F., Hancock, G. R., & Brand, B. L. (2004). Parental Attachment, Separation-Individuation, and College Student Adjustment: A Structural Equation Analysis of Mediational Effects. *Journal of counseling psychology, 51*(2), 213.

Maynes-Aminzade, D., Tan, B.-K., Goulding, K., & Vaucelle, C. (2002). *Hover: conveying remote presence.* Paper presented at the ACM SIGGRAPH 2002 conference abstracts and applications.

McGill, M., Williamson, J. H., & Brewster, S. (2016). Examining the role of smart TVs and VR HMDs in synchronous at-a-distance media consumption. *ACM Transactions on Computer-Human Interaction (TOCHI), 23*(5), 33.

Medaglia, C. M., Alexandru Serbanati. (2010). An Overview of Privacy and Security Issues in the Internet of Things. In *The Internet of Things* (pp. 389-395).

Merton, R., & Barber, E. (1963). Sociological ambivalence. *Sociological Theory: Values and Socio-Cultural Change*, 91-120.

Meyer, W. (2004). *The body's surface as a multimedia interface: closed-eyes nonverbal telehaptic communication.* Paper presented at the ACM SIGGRAPH 2004 Sketches.

Miczo, N., Mariani, T., & Donahue, C. (2011). The strength of strong ties: Media multiplexity, communication motives, and the maintenance of geographically close friendships. *Communication Reports, 24*(1), 12-24.

Milic-Frayling, N., Hicks, M., Jones, R., & Costello, J. (2008). *Exploring personal broadcast channels for rich media sharing in close relationships.* Paper presented at the Proceedings of the 7th International Conference on Mobile and Ubiquitous Multimedia.

Miller-Day, M. A. (2004). *Communication among grandmothers, mothers, and adult daughters: A qualitative study of maternal relationships*: Routledge.

Miller-Ott, A. E., Kelly, L., & Duran, R. L. (2012). The effects of cell phone usage rules on satisfaction in romantic relationships. *Communication Quarterly, 60*(1), 17-34.

Miner, C. S., Chan, D. M., & Campbell, C. (2001). *Digital jewelry: wearable technology for everyday life.* Paper presented at the CHI'01 extended abstracts on Human factors in computing systems.

Mok, D., Wellman, B., & Carrasco, J. (2010). Does distance matter in the age of the internet? *Urban Studies, 47*(13), 2747-2783.

Monk, C. A., Boehm-Davis, D. A., & Trafton, J. G. (2002). *The attentional costs of interrupting task performance at various stages.* Paper presented at the Proceedings of the human factors and ergonomics society annual meeting.

Motamedi, N. (2007). *Keep in touch: a tactile-vision intimate interface.* Paper presented at the Proceedings of the 1st international conference on Tangible and embedded interaction.

Moussette, C. (2007). Tangible interaction toolkits for designers

Mueller, F. F., Vetere, F., Gibbs, M. R., Kjeldskov, J., Pedell, S., & Howard, S. (2005). *Hug over a distance.* Paper presented at the CHI'05 extended abstracts on Human factors in computing systems.

Mynatt, E. D., Rowan, J., Craighill, S., & Jacobs, A. (2001). *Digital family portraits: supporting peace of mind for extended family members.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Mynatt, E. D., Rowan, J., Tran, Q., Abowd, G., Rogers, W., & Siio, I. (2003). Designing home appliances for older adults. *Cognitive Studies, 10*(3), 343-352.

Nakanishi, J., Kuwamura, K., Minato, T., Nishio, S., & Ishiguro, H. (2013). *Evoking affection for a communication partner by a robotic communication medium.* Paper presented at the The First International Conference on Human-Agent Interaction (iHAI 2013).

Nanayakkara, S., Shilkrot, R., Yeo, K. P., & Maes, P. (2013). *EyeRing: a finger-worn input device for seamless interactions with our surroundings.* Paper presented at the Proceedings of the 4th Augmented Human International Conference.

Neustaedter, C., Elliot, K., & Greenberg, S. (2006). *Interpersonal awareness in the domestic realm.* Paper presented at the Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments.

Neustaedter, C., Pang, C., Forghani, A., Oduor, E., Hillman, S., Judge, T. K., . . . Greenberg, S. (2015). Sharing Domestic Life through Long-Term Video Connections. *ACM Trans. Comput.-Hum. Interact., 22*(1), 1-29. doi:10.1145/2696869

Newman, B. M., & Newman, P. R. (2017). *Development through life: A psychosocial approach*: Cengage Learning.

O'Brien, S., & Mueller, F. F. (2006). *Holding hands over a distance: technology probes in an intimate, mobile context.* Paper presented at the Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments.

O'Hara, K., Harper, R., Unger, A., Wilkes, J., Sharpe, B., & Jansen, M. (2005). *TxtBoard: from text-to-person to text-to-home.* Paper presented at the CHI'05 extended abstracts on Human factors in computing systems.

Ofcom. (2017). *Smartphone ownership penetration in the United Kingdom (UK) in 2012-2017, by age*. Retrieved from https://www.statista.com/statistics/271851/smartphone-owners-in-the-united-kingdom-uk-by-age/

Ogawa, H., Ando, N., & Onodera, S. (2005). *SmallConnection: designing of tangible communication media over networks.* Paper presented at the Proceedings of the 13th annual ACM international conference on Multimedia.

Onayli, S., & Erdur-Baker, O. (2013). Mother-daughter Relationship and Daughter's Self Esteem. *Procedia-Social and Behavioral Sciences, 84*, 327-331.

ONS. (2011). *2011 Census: Key Statistics for England and Wales, March 2011*. Retrieved from https://www.ons.gov.uk/census/2011census

ONS. (2017). *Internet users in the UK: 2017*. Retrieved from https://www.ons.gov.uk/businessindustryandtrade/itandinternetindustry/bulletins/internetusers/2017

Padilla-Walker, L. M., Nelson, L. J., Carroll, J. S., & Jensen, A. C. (2010). More than a just a game: video game and internet use during emerging adulthood. *Journal of youth and adolescence, 39*(2), 103-113.

Palen, L., Salzman, M., & Youngs, E. (2000). *Going wireless: behavior & practice of new mobile phone users.* Paper presented at the Proceedings of the 2000 ACM conference on Computer supported cooperative work.

Pallant, J. (2013). *SPSS survival manual*: McGraw-Hill Education (UK).

Park, Y.-W., Baek, K.-M., & Nam, T.-J. (2013). *The roles of touch during phone conversations: long-distance couples' use of POKE in their homes.* Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.

Park, Y.-W., Park, J., & Nam, T.-J. (2015). *The trial of bendi in a coffeehouse: use of a shape-changing device for a tactile-visual phone conversation.* Paper presented at the Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems.

Parreñas, R. (2005). Long distance intimacy: class, gender and intergenerational relations between mothers and children in Filipino transnational families. *Global networks, 5*(4), 317-336.

Patel, D., & Agamanolis, S. (2003). *Habitat: awareness of life rhythms over a distance using networked furniture.* Paper presented at the Adjunct Proceedings of UbiComp 2003 Fifth International Conference on Ubiquitous Computing, Seattle.

Paulos, E. (2003). *Connexus: a communal interface.* Paper presented at the Proceedings of the 2003 conference on Designing for user experiences.

Pedersen, E. R. (1998). *People presence or room activity supporting peripheral awareness over distance.* Paper presented at the CHI 98 conference summary on Human factors in computing systems.

Pempek, T. A., Yermolayeva, Y. A., & Calvert, S. L. (2009). College students' social networking experiences on Facebook. *Journal of applied developmental psychology, 30*(3), 227-238.

Pensas, H., Liolis, K., Vainio, A.-M., Wöckl, B., Kivimäki, T., & Vanhala, J. (2012). *Ambient communication and sense of presence device.* Paper presented at the Proceeding of the 16th International Academic MindTrek Conference.

Pillemer, K., Munsch, C. L., Fuller-Rowell, T., Riffin, C., & Suitor, J. J. (2012). Ambivalence toward adult children: Differences between mothers and fathers. *Journal of Marriage and Family, 74*(5), 1101-1113.

Pillemer, K., Suitor, J. J., Pardo, S., & Henderson, C. (2010). Mothers' differentiation and depressive symptoms among adult children. *Journal of Marriage and Family, 72*(2), 333-345.

Pradana, G. A., Cheok, A. D., Inami, M., Tewell, J., & Choi, Y. (2014). *Emotional priming of mobile text messages with ring-shaped wearable device using color lighting and tactile expressions.* Paper presented at the Proceedings of the 5th Augmented Human International Conference.

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon, 9*(5), 1-6.

Pujol, R. S., & Umemuro, H. (2009). *Productive love: a new approach for designing affective technology.* Paper presented at the CHI'09 Extended Abstracts on Human Factors in Computing Systems.

Ramsey, M. A., Gentzler, A. L., Morey, J. N., Oberhauser, A. M., & Westerman, D. (2013). College students' use of communication technology with parents: comparisons between two cohorts in 2009 and 2011. *Cyberpsychology, Behavior, and Social Networking, 16*(10), 747-752.

Rastogi, M. (2002). The mother-adult daughter questionnaire (MAD): Developing a culturally sensitive instrument. *The Family Journal, 10*(2), 145-155.

Rastogi, M., & Wampler, K. S. (1999). Adult daughters' perceptions of the mother-daughter relationship: A cross-cultural comparison. *Family Relations*, 327-336.

Raup, J. L., & Myers, J. E. (1989). The empty nest syndrome: myth or reality? *Journal of Counseling & Development, 68*(2), 180-183.

Reichl, P., Froehlich, P., Baillie, L., Schatz, R., & Dantcheva, A. (2007). *The LiLiPUT prototype: a wearable lab environment for user tests of mobile telecommunication applications.* Paper presented at the CHI'07 extended abstracts on Human factors in computing systems.

Rettie, R. (2003). *Connectedness, awareness and social presence.* Paper presented at the PRESENCE 2003.

Rittenbruch, M., & McEwan, G. (2009). An historical reflection of awareness in collaboration. In *Awareness Systems* (pp. 3-48): Springer.

Rogers, Y. (2012). HCI theory: classical, modern, and contemporary. *Synthesis Lectures on Human-Centered Informatics, 5*(2), 1-129.

Rogers, Y., Sharp, H., & Preece, J. (2011). *Interaction design: beyond human-computer interaction*: John Wiley & Sons.

Rogerson, K. (2008). Mobile Communication and Society: A Global Perspective, Manuel Castells, Mireia Fernández-Ardèvol, Jack Linchuan Qiu, and Araba Sey. *Journal of Information Technology & Politics, 5*(1), 154-155. doi:10.1080/19331680802042373

Romero, N., Markopoulos, P., van Baren, J., de Ruyter, B., Ijsselsteijn, W., & Farshchian, B. (2007). Connecting the family with awareness systems. *Personal and Ubiquitous Computing, 11*(4), 299-312. doi:10.1007/s00779-006-0089-0

Rossi, P. P. H. (1990). *Of human bonding: Parent-child relations across the life course*: Transaction Publishers.

Rovers, A., & van ESSEN, H. A. (2004). *HIM: a framework for haptic instant messaging.* Paper presented at the CHI'04 Extended Abstracts on Human Factors in Computing Systems.

Rowan, J., & Mynatt, E. D. (2005). *Digital family portrait field trial: Support for aging in place.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Rubin, O. (2015). Contact between parents and adult children: the role of time constraints, commuting and automobility. *Journal of transport geography, 49*, 76-84.

Samani, H. A., Parsani, R., Rodriguez, L. T., Saadatian, E., Dissanayake, K. H., & Cheok, A. D. (2012). *Kissenger: design of a kiss transmission device.* Paper presented at the Proceedings of the Designing Interactive Systems Conference.

Saslis-Lagoudakis, G., Cheverst, K., Dix, A., Fitton, D., & Rouncefield, M. (2006). *Hermes@ Home: supporting awareness and intimacy between distant family members.* Paper presented at the Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments.

Schaefer, M. T., & Olson, D. H. (1981). Assessing Intimacy: The Pair Inventory*. *Journal of Marital and Family Therapy, 7*(1), 47-60.

Schoeni, R. F., & Ross, K. E. (2005). *Material Assistance from Families during the Transition to Adulthood*: University of Chicago Press.

Schon, J. (2013). *" I'M JUST TEXTING TO SAY HELLO": EXAMINING HOW PARENTS'ACCESS TO AND USE OF INFORMATION COMMUNICATION TECHNOLOGIES INFLUENCES SATISFACTION AMONG ADULT CHILDREN.* University of Kansas,

Schon, J. (2014). "Dad Doesn't Text" Examining How Parents' Use of Information Communication Technologies Influences Satisfaction Among Emerging Adult Children. *Emerging Adulthood, 2*(4), 304-312.

Sekiguchi, D., Inami, M., & Tachi, S. (2001). *RobotPHONE: RUI for interpersonal communication.* Paper presented at the CHI'01 Extended Abstracts on Human Factors in Computing Systems.

Sellen, A., Eardley, R., Izadi, S., & Harper, R. (2006). *The whereabouts clock: early testing of a situated awareness device.* Paper presented at the CHI'06 extended abstracts on human factors in computing systems.

Sellen, A., Harper, R., Eardley, R., Izadi, S., Regan, T., Taylor, A. S., & Wood, K. R. (2006). *HomeNote: supporting situated messaging in the home.* Paper presented at the Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work.

Selwyn, N., Gorard, S., Furlong, J., & Madden, L. (2003). Older adults' use of information and communications technology in everyday life. *Ageing & Society, 23*(5), 561-582.

Senft, G. (2009). Phatic communion. *Culture and language use, 2*, 226-233.

Sharmeen, F., Arentze, T., & Timmermans, H. (2014). Dynamics of face-to-face social interaction frequency: role of accessibility, urbanization, changes in geographical distance and path dependence. *Journal of transport geography, 34*, 211-220.

Shin, H., Lee, J., Park, J., Kim, Y., Oh, H., & Lee, T. (2007). *A tactile emotional interface for instant messenger chat.* Paper presented at the Symposium on Human Interface and the Management of Information.

Short, J., Williams, E., & Christie, B. (1976). The social psychology of telecommunications.

Siio, I., Rowan, J., Mima, N., & Mynatt, E. D. (2003). *Digital Decor: Augmented Everyday Things.* Paper presented at the Graphics Interface.

Silina, Y., & Haddadi, H. (2015a). The Distant Heart: Mediating Long-Distance Relationships through Connected Computational Jewelry. *arXiv preprint arXiv:1505.00489*.

Silina, Y., & Haddadi, H. (2015b). *New directions in jewelry: a close look at emerging trends & developments in jewelry-like wearable devices*. Paper presented at the Proceedings of the 2015 ACM International Symposium on Wearable Computers, Osaka, Japan.

Silverstein, M., Parrott, T. M., & Bengtson, V. L. (1995). Factors that predispose middle-aged sons and daughters to provide social support to older parents. *Journal of Marriage and the Family*, 465-475.

Smith, A. (2014). *Older adults and technology use*: Pew Research Center [Internet & American Life Project].

Soro, A., Brereton, M., & Roe, P. (2015). *The Messaging Kettle: It's IoTea time.* Paper presented at the 33rd Annual ACM Conference on Human Factors in Computing Systems. .

Spitze, G., & Logan, J. (1990a). More evidence on women (and men) in the middle. *Research on aging, 12*(2), 182-198.

Spitze, G., & Logan, J. (1990b). Sons, daughters, and intergenerational social support. *Journal of Marriage and the Family*, 420-430.

Stafford, L. (2004). *Maintaining long-distance and cross-residential relationships*: Routledge.

Steinbach, A., & Kopp, J. (2007). Explaining the frequency of contact between generations in Germany.

Stojkoska, B. L. R., & Trivodaliev, K. V. (2017). A review of Internet of Things for smart home: Challenges and solutions. *Journal of Cleaner Production, 140*, 1454-1464.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology. *Handbook of qualitative research, 17*, 273-285.

Streitz, N. A., Röcker, C., Prante, T., Stenzel, R., & van Alphen, D. (2003). *Situated interaction with ambient information: Facilitating awareness and communication in ubiquitous work environments.* Paper presented at the Tenth International Conference on Human-Computer Interaction (HCI International 2003).

Strong, R., & Gaver, B. (1996). *Feather, scent and shaker: supporting simple intimacy.* Paper presented at the Proceedings of CSCW.

Sundström, P., Ståhl, A., & Höök, K. (2007). In situ informants exploring an emotional mobile messaging system in their everyday practice. *International Journal of Human-Computer Studies, 65*(4), 388-403.

Suzuki, K., & Hashimoto, S. (2004). *Feellight: a communication device for distant nonverbal exchange.* Paper presented at the Proceedings of the 2004 ACM SIGMM workshop on Effective telepresence.

Swartz, T. T. (2009). Intergenerational family relations in adulthood: Patterns, variations, and implications in the contemporary United States. *Annual review of sociology, 35*, 191-212.

TacTilu. (2013). TACTILU - Remote Touch Communicator. Retrieved from http://www.dudeiwantthat.com/gear/gadgets/tactilu-remote-touch-communicator.asp

Tao, H.-L. (2014). Why do women interact with their parents more often than men? The demonstration effect vs. the biological effect. *The Social Science Journal, 51*(3), 350-360.

Tashakkori, A., & Teddlie, C. (2010). *Sage handbook of mixed methods in social & behavioral research*: Sage.

Taylor, Funk, C., Craighill, P., & Kennedy, C. (2006). Families drawn together by communication revolution. *Pew Research Center. Retrieved from ht tp://www. pewsocialtrends. org/files/2010/10/FamilyBonds. pdf*.

Taylor, & Ledbetter. (2017). Extending media multiplexity theory to the extended family: Communication satisfaction and tie strength as moderators of violations of media use expectations. *New Media & Society, 19*(9), 1369-1387.

Taylor, A. S., & Harper, R. (2003). The gift of the gab?: A design oriented sociology of young people's use of mobiles. *Computer Supported Cooperative Work (CSCW), 12*(3), 267-296.

Tee, K., Brush, A. B., & Inkpen, K. M. (2009). Exploring communication and sharing between extended families. *International Journal of Human-Computer Studies, 67*(2), 128-138.

Teh, J., Lee, S. P., & Cheok, A. D. (2005). *Internet. pajama.* Paper presented at the Proceedings of the 2005 international conference on Augmented tele-existence.

theTouch. (2016). HB Ring - Real-time heartbeat of loved one on your ring. .

Thieme, A., Wallace, J., Thomas, J., Le Chen, K., Krämer, N., & Olivier, P. (2011). Lovers' box: Designing for reflection within romantic relationships. *International Journal of Human-Computer Studies, 69*(5), 283-297.

Thompson, A., Friedland, A., & Cargiuolo, J. (2005). *Rüüg: long-distance communication.* Paper presented at the CHI'05 Extended Abstracts on Human Factors in Computing Systems.

Thompson, L., & Walker, A. J. (1984). Mothers and daughters: Aid patterns and attachment. *Journal of Marriage and the Family*, 313-322.

Thornton, A., Orbuch, T. L., & Axinn, W. G. (1995). Parent-child relationships during the transition to adulthood. *Journal of Family Issues, 16*(5), 538-564.

Tollmar, K., Junestrand, S., & Torgny, O. (2000). *Virtually living together.* Paper presented at the Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques.

Tollmar, K., & Persson, J. (2002). *Understanding remote presence.* Paper presented at the Proceedings of the second Nordic conference on Human-computer interaction.

Townsend, A. M. (2000). Life in the real-time city: Mobile telephones and urban metabolism. *Journal of urban technology, 7*(2), 85-104.

Treas, J., & Gubernskaya, Z. (2012). Farewell to moms? Maternal contact for seven countries in 1986 and 2001. *Journal of Marriage and Family, 74*(2), 297-311.

Trommsdorff, G., & Schwarz, B. (2007). TheIntergenerational Stake Hypothesis' in Indonesia and Germany: Adult Daughters' and their Mothers' Perception of their Relationship. *Current sociology, 55*(4), 599-620.

Truong, K. N., Richter, H., Hayes, G. R., & Abowd, G. D. (2004). *Devices for sharing thoughts and affection at a distance.* Paper presented at the CHI'04 Extended Abstracts on Human Factors in Computing Systems.

Tsetserukou, D. (2010). Haptihug: A novel haptic display for communication of hug over a distance. In *Haptics: Generating and Perceiving Tangible Sensations* (pp. 340-347): Springer.

Tsetserukou, D., & Neviarouskaya, A. (2010). *World's first wearable humanoid robot that augments our emotions*. Paper presented at the Proceedings of the 1st Augmented Human International Conference, Meg\&\#232;ve, France. http://delivery.acm.org/10.1145/1790000/1785463/a8-tsetserukou.pdf?ip=138.38.82.253&id=1785463&acc=ACTIVE%20SERVICE&key=BF07A2EE685417C5%2E85B475708465C551%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1517951355_1eefcc44770b4c4ca48d1fe8a9912ac3

Tsetserukou, D., Neviarouskaya, A., Prendinger, H., Ishizuka, M., & Tachi, S. (2010). *iFeel_IM: innovative real-time communication system with rich emotional and haptic channels*. Paper presented at the CHI '10 Extended Abstracts on Human Factors in Computing Systems, Atlanta, Georgia, USA. http://delivery.acm.org/10.1145/1760000/1753911/p3031-tsetserukou.pdf?ip=138.38.82.253&id=1753911&acc=ACTIVE%20SERVICE&key=BF07A2EE685417C5%2E85B475708465C551%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1517951348_b2f7ed3c6c4b75bb4bde792012b17a8c

Tsujita, H., Siio, I., & Tsukada, K. (2007). *SyncDecor: appliances for sharing mutual awareness between lovers separated by distance.* Paper presented at the CHI'07 Extended Abstracts on Human Factors in Computing Systems.

Tsujita, H., Tsukada, K., & Siio, I. (2009). *InPhase: a communication system focused on happy coincidences of daily behaviors.* Paper presented at the CHI'09 Extended Abstracts on Human Factors in Computing Systems.

Tu, C.-H. (2002). The measurement of social presence in an online learning environment.

Turner, P., & Turner, S. (2004). *Insideness and outsideness: Characterizing the experiences of real and virtual places.* Paper presented at the Proceedings of the seventh international workshop on presence.

Turner, P., & Turner, S. (2006). Place, sense of place, and presence. *Presence: Teleoperators & Virtual Environments, 15*(2), 204-217.

Turner, P., Turner, S., & Carroll, F. (2005). The tourist gaze: Towards contextualised virtual environments. In *Spaces, spatiality and technology* (pp. 281-297): Springer.

Ullmer, B., & Ishii, H. (1999). *musicbox: A Tangible Interface for Remote Presence and Browsable History.* Paper presented at the UIST'99.

Valkenburg, P. M., & Peter, J. (2007). Preadolescents' and adolescents' online communication and their closeness to friends. *Developmental psychology, 43*(2), 267.

Van Cleemput, K. (2010). "I'll see you on IM, text, or call you": A social network approach of adolescents' use of communication media. *Bulletin of Science, Technology & Society, 30*(2), 75-85.

Vaughn, M. J., & Matyastik Baier, M. E. (1999). Reliability and validity of the relationship assessment scale. *American Journal of Family Therapy, 27*(2), 137-147.

Vaux, A. (1988). *Social support: Theory, research, and intervention*: Praeger publishers.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Versteeg, M., van den Hoven, E., & Hummels, C. (2016). *Interactive Jewellery: a design exploration.* Paper presented at the Proceedings of the TEI'16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction.

Vetere, F., Gibbs, M. R., Kjeldskov, J., Howard, S., Mueller, F. F., Pedell, S., . . . Bunyan, M. (2005). *Mediating intimacy: designing technologies to support strong-tie relationships.* Paper presented at the Proceedings of the SIGCHI conference on Human factors in computing systems.

Vetere, F., Nolan, M., & Raman, R. A. (2006). *Distributed hide-and-seek.* Paper presented at the Proceedings of the 18th Australia conference on computer-human interaction: design: activities, artefacts and environments.

Visser, T., Vastenburg, M. H., & Keyson, D. V. (2011). Designing to support social connectedness: The case of SnowGlobe. *International Journal of Design, 5*(3).

Wallace, J. (2007). *Emotionally charged: A practice-centred enquiry of digital jewellery and personal emotional significance.* Sheffield Hallam University (United Kingdom),

Wallace, J., Dearden, A., & Fisher, T. (2007). The significant other: the value of jewellery in the conception, design and experience of body focused digital devices. *AI & SOCIETY, 22*(1), 53-62.

Wallace, J., Thieme, A., Wood, G., Schofield, G., & Olivier, P. (2012). *Enabling self, intimacy and a sense of home in dementia: an enquiry into design in a hospital setting*. Paper presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Austin, Texas, USA.

Wallbaum, T., Timmermann, J., Heuten, W., & Boll, S. (2015). *Forget Me Not: Connecting Palliative Patients and Their Loved Ones.* Paper presented at the Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems.

Ward, R., Deane, G., & Spitze, G. (2014). Life-course changes and parent–adult child contact. *Research on aging, 36*(5), 568-602.

Warehouse, C. (2006). The mobile life report 2006: How mobile phones change the way we live. Retrieved from http://www.mobilelife2006.co.uk/

Waycott, J., Bennett, S., Kennedy, G., Dalgarno, B., & Gray, K. (2010). Digital divides? Student and staff perceptions of information and communication technologies. *Computers & education, 54*(4), 1202-1211.

Wei, R., & Lo, V.-H. (2006). Staying connected while on the move: Cell phone use and social connectedness. *New Media & Society, 8*(1), 53-72.

Werner, J., Wettach, R., & Hornecker, E. (2008). *United-pulse: feeling your partner's pulse.* Paper presented at the Proceedings of the 10th international conference on Human computer interaction with mobile devices and services.

Wethington, E., & Kessler, R. C. (1986). Perceived support, received support, and adjustment to stressful life events. *Journal of Health and Social behavior*, 78-89.

White, L., & Edwards, J. N. (1990). Emptying the Nest and Parental Well-Being: An Analysis of National Panel Data. *American sociological review, 55*(2), 235-242. doi:10.2307/2095629

Williams, A., & Nussbaum, J. F. (2013). *Intergenerational communication across the life span*: Routledge.

Wills, T. A., & Shinar, O. (2000). Measuring perceived and received social support. *Social support measurement and intervention: A guide for health and social scientists*, 86-135.

Wintre, M. G., & Yaffe, M. (2000). First-year students' adjustment to university life as a function of relationships with parents. *Journal of adolescent research, 15*(1), 9-37.

Wisneski, C., Ishii, H., Dahley, A., Gorbet, M., Brave, S., Ullmer, B., & Yarin, P. (1998). Ambient displays: Turning architectural space into an interface

between people and digital information. In *Cooperative buildings: Integrating information, organization, and architecture* (pp. 22-32): Springer.

Wright, K. B. (2005). Researching Internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of computer-mediated communication, 10*(3), JCMC1034.

Wu, Z.-Q., Sun, L., Sun, Y.-H., Zhang, X.-J., Tao, F.-b., & Cui, G.-H. (2010). Correlation between loneliness and social relationship among empty nest elderly in Anhui rural area, China. *Aging Ment Health, 14*(1), 108-112. doi:10.1080/13607860903228796

Yang, Brown, B. B., & Braun, M. T. (2013). From Facebook to cell calls: Layers of electronic intimacy in college students' interpersonal relationships. *New Media & Society*, 1461444812472486.

Yang, Y., Wu, L., Yin, G., Li, L., & Zhao, H. (2017). A survey on security and privacy issues in internet-of-things. *IEEE Internet of Things Journal, 4*(5), 1250-1258.

Yarosh, S. (2008). *Supporting parent-child interaction in divorced families.* Paper presented at the Proceedings of the 7th international conference on Interaction design and children.

Yarosh, S., Markopoulos, P., & Abowd, G. D. (2014). *Towards a questionnaire for measuring affective benefits and costs of communication technologies.* Paper presented at the Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing.

Yasuda, S., Hashimoto, S., Koizumi, M., & Okude, N. (2007). *Teleshadow: feeling presence in private spaces.* Paper presented at the ACM SIGGRAPH 2007 sketches.

Zegarac, V. (1998). What is" Phatic Communication"? *Pragmatics AND Beyond New Series*, 327-362.

Zickuhr, K. (2011). Generations and their gadgets. *Pew Internet & American Life Project, 20*.

Zuckerman, O., & Maes, P. (2005). *Awareness system for children in distributed families.* Paper presented at the interaction design for children.

8 Appendix A

8.1 Devices to support long distance relationships

Name of the system	Strategies	Synchronous/ Asynchronous	Type of users' relationships	Evaluated/Not Evaluated
Peek-A-Drawer (Siio, Rowan, Mima, & Mynatt, 2003)	Expressivity, Awareness	Asynchronous 1 way	Grandparents - grandchildren	Field test with two families
Presence Displays (Dey & de Guzman, 2006)	Awareness	synchronous, bi-directional (two-way)	Friends and family	Contextual inquiries and field studies
LumiTouch (Chang et al., 2001)	Awareness, Expressivity	Synchronous. bi-directional	Not specified	Preliminary testing was done with users who were not emotionally involved with each other.
ComSlipper (Chen et al., 2006)	Awareness, Expressivity	Synchronous. bi-directional	2 people- any	Field study with five people for three days.
ComTouch (Chang et al., 2002)	Expressivity	Synchronous. bi-directional	2 people- any	Yes, but focus is on ergonomics and not its ability to support people's relationships
FeelLight (Suzuki & Hashimoto, 2004)	Awareness	Synchronous. bi-directional	2 people- any	A lab study was carried out with 25 user that tried the prototype for 20 minutes. No proper evaluation or results were found
VIO (Kaye, 2006)	Awareness, Expressivity	Synchronous	Romantic partners	Five Romantic partners for one week used VIO

InTouch (Brave & Dahley, 1997)	Physicalness	synchronous	2 people- any	Preliminary study. no proper evaluation found
RobotPHONE(Sekiguchi, Inami, & Tachi, 2001)	Awareness, Expressivity	synchronous	2 people - any	No evaluation found
Feather(Strong & Gaver, 1996)	Expressivity, Physicalness	Asynchronous, 1-way	Romantic partners	No evaluation found
Scent(Strong & Gaver, 1996)	Expressivity, Physicalness	Synchronous 1 way	Romantic partners	No evaluation found
Shaker (Strong & Gaver, 1996)	Expressivity, Physicalness	Synchronous 2 way	Less intimate friendships	No evaluation found
Hand Jive (Fogg, Cutler, Arnold, & Eisbach, 1998)	Joint action	Synchronous 2 way	2 people- any	Unspecified user tests
Flexible Displays (Elliot & Greenberg, 2004)	Awareness	Asynchronous. One way	2 or more people	No evaluation found
Hydra units (Buxton, 1992)	Awareness, Joint action	Synchronous multi-way	Co-workers	No evaluation found
The dragonfly surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	Co-workers	No evaluation found
peek-a-boo surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	Co-workers	No evaluation found
The light surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	Co-workers	No evaluation found
Mutant ninja surrogate(Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	Co-workers	No evaluation found
Responding surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	co-workers	No evaluation found

Proximity surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous	co-workers	No evaluation found
The Active Hydra surrogate (Greenberg & Kuzuoka, 1999)	Awareness, Joint action	Synchronous. two way	co-workers	No evaluation found
Romantic partners' Box (Thieme et al., 2011)	Gift giving	Asynchronous	Romantic partners	Yes- but has many limitation as users had to visit lab
Sensing beds (Goodman & Misilim, 2003)	Physicalness, Awareness	Synchronous	Romantic partners	Yes, 40 pairs over 2 days tried a bench prototype.
the 6th sense (Tollmar & Persson, 2002)	Awareness	Asynchronous 1 way	Families	2 week study with 3 families
ASTRA Awareness System (Markopoulos et al., 2004)	Gift giving	Asynchronous	Families	Field experiment with 2 households
YourGloves (Gooch & Watts, 2012b)	Physicalness	Synchronous	Romantic partners	Yes- Laboratory study asking 12 participants their opinion on the system
Hothands (Gooch & Watts, 2012b)	Physicalness	Synchronous	Romantic partners	Yes- Laboratory study asking 12 participants their opinion on the system
HotMitts (Gooch & Watts, 2012b)	Physicalness	Synchronous	Romantic partners	Yes- Laboratory study asking 12 participants their opinion on the system

TapTap (Bonanni, Vaucelle, Lieberman, & Zuckerman, 2006)	Physicalness	Asynchronous	Family, Romantic partners, therapist and many others	Only pilot study done as this was work in progress
Hug- Air-inflatable vest- consists of stuffed toy and a vest (Mueller et al., 2005)	Physicalness	Synchronous	Romantic partners	Yes- 6 Romantic partners
The Hug (Gemperle, DiSalvo, Forlizzi, & Yonkers, 2003)	Physicalness, Expressivity	Synchronous + Asynchronous 2 way	Family, Romantic partners	No evaluation found
White Stone (Tollmar et al., 2000)	Physicalness	Synchronous 2 way	Family	Eight rapid ethnographic studies were performed (in two series of four families each)
Simulating hug for autistic kids (Mueller et al., 2005)	Physicalness	Synchronous 1 way	Sensory seeking children and adults	Design workshop with 6 Romantic partners
The Gustbowl (Keller et al., 2004)	Expressivity, Awareness	Synchronous 2 way	Mother and son	A short study but no results reported.
HaptiHug (Tsetserukou, 2010)	Physicalness	synchronous	2 users wearing the system	No evaluation found
HaptiHeart (Tsetserukou & Neviarouskaya, 2010)	Expressivity, Awareness	synchronous	2 users wearing the system	No evaluation found
HaptiButterfly (Tsetserukou & Neviarouskaya, 2010)	Expressivity, Awareness	Synchronous	1 user wearing system	No evaluation found

HaptiTickler (Tsetserukou & Neviarouskaya, 2010)	Physicalness, Awareness	synchronous	1 user wearing the system	No evaluation found
HaptiTemper (Tsetserukou & Neviarouskaya, 2010)	Expressivity	synchronous	1 user wearing system	No evaluation found
HaptiShiver (Tsetserukou & Neviarouskaya, 2010)	Expressivity	synchronous	1 user wearing the system	No evaluation found
iFeel_IM! (Tsetserukou, Neviarouskaya, Prendinger, Ishizuka, & Tachi, 2010)	Expressivity, Physicalness, Awareness	synchronous	2 Users playing second life	No evaluation found
Keep in Touch (Motamedi, 2007)	Physicalness, Expressivity	synchronous 2 way	Romantic partners	No formal evaluation found
Hugvie (Nakanishi, Kuwamura, Minato, Nishio, & Ishiguro, 2013)	Physicalness, Awareness	Asynchronous 1 way	2 strangers	Six partners then 39 males
Kissenger (Samani et al., 2012)	Physicalness, Expressivity	synchronous	Partners	Seven Romantic partners tried the object
HugMe (Cha, Eid, Barghout, Rahman, & El Saddik, 2009)	Physicalness	synchronous	Romantic partners	No evaluation found
EmoJacket (Arafsha, Alam, & El Saddik, 2012)	Physicalness	synchronous	Not specified	Consumer centric, 92 people surveyed
Hugginess (Angelini et al., 2014)	Physicalness	synchronous	2 people – any	No evaluation found

Kiss communicator (Gaver, 2002)	Physicalness	synchronous	Romantic partners	No evaluation found
SmallConnection: Air, Anemo, One	Awareness	synchronous	2 people - any	No evaluation found
Gumball Machine (Truong et al., 2004)	Expressivity	asynchronous	Many to one, Family	No evaluation found
Picture frame (Truong et al., 2004)	Expressivity	synchronous and Asynchronous	Family and friends	No evaluation found
'TSUNAGARI (Itoh, Miyajima, & Watanabe, 2002)	Awareness	synchronous	2 people- any	Yes
The Cube (Howard et al., 2006)	Gift giving	Asynchronous 2-way	Romantic partners	Yes, 5 Romantic partners 6 week period as a technology probe
HomeNote (Sellen, Harper, et al., 2006)	Expressivity	Synchronous and Asynchronous	Blind families	Yes- 5 month case study
Hermes@Home (Saslis-Lagoudakis et al., 2006)	Expressivity	Asynchronous 1 way	Romantic partners	A case study
Mobile flipper/Desktop flipper (Counts & Fellheimer, 2004)	Gift giving	Synchronous 2 way	Family and friends	Yes, Field study of two weeks
Social Television (Harboe et al., 2008)	Awareness	Synchronous	Family and friends	Yes
United Pulse (Werner, Wettach, & Hornecker, 2008)	Awareness	Synchronous	Family and friends	Laboratory study consisted of 6 Romantic partners (12 persons) and 16 individuals (the partner not taking part in the test).

FamilyPlanter (Itoh et al., 2002)	Awareness, Expressivity	synchronous, bi-directional (two-way)	Family	Field test with four families
SyncDecor-SyncLamp (Itoh et al., 2002)	Awareness, Expressivity	synchronous, bi-directional (two-way)	Romantic partners	Yes. Field test with 3 Romantic partners
SyncDecor-SyncTrash (Itoh et al., 2002)	Awareness, Expressivity	synchronous, bi-directional (two-way)	Romantic partners	Yes. Field test with 3 Romantic partners
SyncDecor-SyncAroma (Itoh et al., 2002)	Awareness, Expressivity	synchronous, bi-directional (two-way)	Romantic partners	Yes. Field test with 3 Romantic partners
SyncDecor-SyncTV (Itoh et al., 2002)	Awareness, Expressivity	synchronous, bi-directional (two-way)	Romantic partners	Yes. Field test with 3 Romantic partners
Ruug (Thompson, Friedland, & Cargiuolo, 2005)	Awareness, Joint Action	synchronous	friends	Surveys and interviews
Habitat (Patel & Agamanolis, 2003)	Awareness	synchronous	Romantic partners	No evaluation found
Social Radio (Patel & Agamanolis, 2003)	Awareness	synchronous mulit-way	Multiple people, a small group	Informal study
SleepyWhispers (Gooch & Watts, 2012a)	Physicalness	Asynchronous 1 way	Romantic partners	Case study of 1 couple for 8 weeks
Magic Sock Drawer (Gooch & Watts, 2011a)	Physicalness	Asynchronous 1 way	Romantic partners	Pilot study with 1 couple for 6 weeks
TCON (Shin et al., 2007)	Expressivity	synchronous	2 People- any	79 people surveyed
HIM (Rovers & van ESSEN, 2004)	Expressivity, Physicalness	Synchronous, 2 way	Teenagers	No evaluation found
SynchroMate (Gibbs, Vetere, Bunyan, & Howard, 2005)	Joint Action	Synchronous, 2 way.	Romantic partners	No evaluation found

Hello There (King & Forlizzi, 2007)	Gift Giving	Asynchronous 2 way	Romantic partners	No evaluation found
GossipWall (Streitz, Röcker, Prante, Stenzel, & van Alphen, 2003)	Awareness	Synchronous, multi way	Co-worker	No evaluation found
ViewPort (Streitz et al., 2003)	Awareness	Synchronous, multi way	Co-worker	No evaluation found
Mutsugoto / pillow talk (Hayashi et al., 2008)	Joint Action, Expressivity	Synchronous, 2 way.	Romantic partners	No evaluation found
SMOKS (Berzowska & Coelho, 2006)	Memories	Asynchronous, 2 way	Romantic partners, friends or strangers.	No evaluation found
WeDo (Visser, Vastenburg, & Keyson, 2011)	Gift giving		Grandparent-grandchild	40-50 people provided feedback at exhibition
KeyPing (Visser et al., 2011)	Awareness	Synchronous 1 way	Grandparent - grandchild	40-50 people provided feedback at exhibition
SnowGlobe (Visser et al., 2011)	Awareness	Synchronous 2 way	Seniors	Six seniors for field trial
Dude's magic box (Mynatt et al., 2003)	Gift giving	Asynchronous, 1 way	Grandparent-grandchild	No evaluation found
Travelling Book (King & Forlizzi, 2007)	Memories	Asynchronous, 2 way	Romantic partners	Yes, 22 interviews.
The Distant Heart- Jewellery Necklace (Silina & Haddadi, 2015a)	Expressivity	Synchronous, 1 way	Romantic partners	Yes, one day study with 6 romantic partners. Questionnaire at the end of the study
Memorabilia Manager (Kjeldskov et al., 2005)	Memories	Asynchronous, 1 way	Families with small children	Cultural probes with a series of contextual interviews

Together Aquarium (Bhandari & Bardzell, 2008)	Joint Action	Synchronous, 2 way	Romantic partners	Semi- structured interviews of eight people
The Trial of Bendi in a Coffeehouse: (Park, Park, & Nam, 2015)	Expressivity, Joint Action	Synchronous, 2 way	Romantic partners	Seven romantic partners, in coffee house for 3 days for used 20 minute per session
ShareTable (Yarosh et al., 2014)	Joint Action	Synchronous, 2 way	Parent – small child	30-minute semi-structured interviews with 5 parents and 5 children (ages 7 – 14) from divorced families
PlayPals (Bonanni et al., 2006)	Joint Action	Synchronous, 2 way	Friends	Observational study with two eight-year-old girls who play together quite often.
MatchUs Board (Bhandari & Bardzell, 2008)	Joint Action, Gift Giving	Synchronous, 2 way	Romantic partners	Semi- structured interviews of eight people in romantic relationships
Lover's Cup (Chung et al., 2006)	Joint Action, Awareness	Synchronous, 2 way	Romantic partners	No evaluation found
InPhase (Vetere, Nolan, & Raman, 2006)	Joint Action	Synchronous, 2 way	Grandparent-grandchild	No evaluation found
TACT (Hoffmann, Jumpertz, & Marquet, 2007)	Joint Action	Synchronous, 2 way	Romantic partners	No evaluation found
Pool of Memory (Battarbee et al., 2002)	Gift Giving	Asynchronous, 1 way.	Strangers	No evaluation found

Seed and Pod (Feltham et al., 2007)	Gift Giving, Expressivity	Asynchronous, 2 way.	Grandparents - grandchild	No evaluation found
Magic Bottle (Feltham et al., 2007)	Gift Giving, Expressivity	Asynchronous, 2 way.	Not specified	No evaluation found
i.Fuzz (Vetere et al., 2005)	Gift Giving	Asynchronous, 2 way.	Romantic partners	No evaluation found
Emotion Container (Lambourne, Feiz, & Rigot, 1997)	Gift Giving, Expressivity	Asynchronous, 2 way.	Best friends	30 people participated in workshops
Cut and Paste Hugs (Howard et al., 2004)	Gift Giving	Asynchronous, 2 way.	Co-habiting Romantic partners	No evaluation found
Bag of Gifts (Feltham et al., 2007)	Gift Giving, Expressivity	Asynchronous, 2 way.	Grandparent-Grandchild	No evaluation found
Audible Gifts (Bhandari & Bardzell, 2008)	Gift Giving	Asynchronous, 2 way.	Romantic partners	No evaluation found
Love Egg (Kaye & Goulding, 2004)	Gift Giving	Asynchronous, 2 way.	Romantic partners	No evaluation found
ShoddyPop (Lindley et al., 2009)	Gift Giving	Asynchronous, 2 way.	Family members	Focus groups with 18 adults, aged from 55 to 81 years.
Wearable Touch (Howard et al., 2004)	Physicalness, Expressivity	Synchronous, 2 way	Romantic partners	No evaluation found
Lovelet (Teh, Lee, & Cheok, 2005)	Physicalness, Expressivity	Synchronous, 1 way	Parent and Child	No evaluation found
ImPulse (Lotan & Croft, 2007)	Physicalness, Awareness	Synchronous, 2 way	Romantic partners	No evaluation found
Hug Over Distance (Mueller et al., 2005)	Physicalness	Synchronous, 1 way	Romantic partners	Six romantic partners in long term relationships and 2 children participated in a

				workshop with the device
Holding Hands over Distance (O'Brien & Mueller, 2006)	Physicalness, Expressivity	No transmission of data	Romantic partners	Interviewed 9 Romantic partners holding hands.
Hand Holding (Kaye & Goulding, 2004)	Physicalness, Expressivity	Synchronous, 2 way	Romantic partners	No evaluation found
Connexus (Paulos, 2003)	Physicalness, Awareness	Synchronous, 2 way	Romantic partners	No evaluation found
Kiss Communicator (Buchenau & Suri, 2000)	Physicalness	Asynchronous, 2 way.	Romantic partners	No evaluation found
Closed-Eyes Nonverbal Telehaptic Communication (Meyer, 2004)	Physicalness	Synchronous, 2 way	Romantic partners	No evaluation found
In Touch (Hindus et al., 2001)	Physicalness, Expressivity	Synchronous, 2 way	Friends or relatives	Yes,16 in depth home interviews, the 35 home interviews, then 4 2-hour focus groups of 10 women
BuddyBeads (Kikin-Gil, 2006)	Expressivity, Memories	Synchronous, 2 way	Friends	No evaluation found
ToTell (Astra) (Markopoulos et al., 2004)	Expressivity, Gift Giving	Asynchronous, 1 way.	Families	Yes, field experiment involving 2 households
The Digital Picture Frame (Truong et al., 2004)	Expressivity	Asynchronous, 1 way.	Strangers	Yes, the frame has been deployed to two people in the same lab.
Teddy Bear (Hemmeryckx-Deleersnijder & Thorne, 2008)	Expressivity, Gift Giving	Asynchronous, 1 way.	Families	Small home trial with 3 families

PersonCards (Lindley et al., 2009)	Expressivity, Gift Giving	Asynchronous, 2 way.	Not mentioned	Three focus groups with 18 adults, aged from 55 to 81 years
One (Ogawa et al., 2005)	Expressivity, Awareness	Synchronous 2 way.	Not mentioned	No evaluation found
Lumicard (Tollmar & Persson, 2002)	Expressivity, Awareness	Asynchronous, 2 way.	Families	A short, pilot ethnographic study was undertaken in ten different households.
InScene (Katsumoto et al., 2006)	Expressivity, Gift Giving	Asynchronous, 2 way.	Romantic partners	No evaluation found
Honey I am home (Kaye & Goulding, 2004)	Expressivity, Awareness	Synchronous 2 way.	Romantic partners	One couple interviewed
FeelLight (Suzuki & Hashimoto, 2004)	Expressivity, Awareness	Synchronous 2 way.	Not mentioned	Yes, 25 subject user test
eMutts (Yarosh, 2008)	Expressivity	Asynchronous, 1 way.	Parent - child	Interviewed 5 children, 10 adults from divorced families
eKISS (Dalsgaard, Skov, & Thomassen, 2007)	Expressivity, Memories	Asynchronous, 1 way.	Families	7 week long cultural probe with 3 families with children
Digital Kiss (Howard et al., 2004)	Expressivity, Gift Giving	Asynchronous, 1 way.	Not specified	No evaluation found
Constant Touch (Kjeldskov et al., 2004)	Expressivity, Awareness	Synchronous 2 way.	Romantic partners	Cultural probe with 6 Romantic partners
CommuteBoard (Hindus et al., 2001)	Expressivity	Synchronous 2 way.	commute sharers	2-hour focus groups of 10 women

Collage (Ashkanasy, Benda, & Vetere, 2007)	Expressivity	Synchronous 1 way.	Inter household	3 families studied
CanCan (Bhandari & Bardzell, 2008)	Expressivity	Synchronous 2 way.	Romantic partners	Yes, interviews with 8 people
Ambient Photo-Frame (Jung & Connelly, 2007)	Expressivity	Synchronous 1 way.	Public with user	No evaluation found
VideoProbe (Hutchinson et al., 2003)	Expressivity	Asynchronous, 1 way.	Family members in different households	Deployed in 3 households of one family and 2 households of another
Tree-lamp (Tollmar & Persson, 2002)	Expressivity	Synchronous 1 way.	2 people- any	Short, pilot ethnographic study was undertaken in ten different households.
MessageProbe (Hutchinson et al., 2003)	Expressivity	Asynchronous, 1 way.	Family members in different households	Deployed in 3 households of one family and 2 households of another
How do I love thee (Kaye & Goulding, 2004)	Expressivity	Synchronous 2 way.	Romantic partners	Yes, One couple interviewed
CASY (Zuckerman & Maes, 2005)	Expressivity	Asynchronous, 1 way.	Grandparents and grandchildren	Yes, A questionnaire study to collect data from four sets of grandparents and grandchildren
VibroBod (Dobson, Ju, Donath, & Ishii, 2001)	Awareness	Synchronous 2 way.	Not specified	Informal critiques with fifteen students and faculty.
SPARCS (Brush, Inkpen, & Tee, 2008)	Awareness, Memories	Asynchronous, 1 way.	Extended families	Interviews with 28 participants

Photoframe (Hemmeryckx-Deleersnijder & Thorne, 2008)	Awareness, Gift Giving	Synchronous 2 way.	Romantic partners	No evaluation found
Our Day (King & Forlizzi, 2007)	Awareness, Memories	Asynchronous, 2 way.	Romantic partners	22 interviews with people in long distance relationships
Long-term Planner Coordination watch (Hoefnagels, Geelhoed, Stappers, Hoeben, & van der Lugt, 2004)	Awareness, Memories	Asynchronous, 1 way.	Families	No evaluation found
eMoto (Sundström, Ståhl, & Höök, 2007)	Awareness, Gift Giving	Asynchronous, 2 way.	Friends	5 user cultural probe and technology probe and experience clips
Teleshadow (Yasuda et al., 2007)	Awareness, Expressivity	Synchronous 2 way.	Friends	No evaluation found
RotatingLights (Dey & de Guzman, 2006)	Awareness, Expressivity	Synchronous 1 way.	Partners	Cultural probe with 7 students
Contextual Photo-Display (Jung & Connelly, 2007)	Awareness	Synchronous 1 way.	Not specified	No evaluation found
Whereabouts Clock (Sellen, Eardley, Izadi, & Harper, 2006)	Awareness	Synchronous 1 way.	Family members	14 people interviewed twice
Watchme (Marmasse, Schmandt, & Spectre, 2004)	Awareness	Synchronous 2 way.	Intimate friends and family	Pilot survey of 26 people and user study of 15 people

TxtBoard (O'Hara et al., 2005)	Awareness	Asynchronous, 1 way.	Family members	Case study of single family over 2 months
Tangible/Virtual MissU (Lottridge et al., 2009)	Awareness, Expressivity	Synchronous 2 way.	Romantic partners	Five romantic partners on short field trial and two romantic partners on month field trial.
SyncSky (Tsujita et al., 2007)	Awareness	Synchronous 2 way.	Romantic partners	Yes. 3 months study with 3 romantic partners
SoftAir Communication (Tollmar et al., 2000)	Awareness	Synchronous 2 way.	Not specified	No evaluation found
ROOMLINK (Hindus et al., 2001)	Awareness, Joint Action	Synchronous 2 way.	Households	Yes,16 in depth home interviews, the 35 home interviews, then 4 2-hour focus groups of 10 women
PresenceStool (Dey & de Guzman, 2006)	Awareness	Synchronous 1 way.	Friends	Online focus group of 8 participants
Presence Light (Hindus et al., 2001)	Awareness	Synchronous 2 way.	Households	2-hour focus groups of 10 women
Portal Frame (Bergstrom & Karahalios, 2006)	Awareness	Asynchronous 1 way.	Not specified	No evaluation found
PictureFrame (Dey & de Guzman, 2006)	Awareness	Synchronous 1 way.	Partners	Online focus group of 8 participants
PhotoDisplay (Dey & de Guzman, 2006)	Awareness	Synchronous 1 way.	Partners	Online focus group of 8 participants
Musicbox (Ullmer & Ishii, 1999)	Awareness	Synchronous 1 way.	Grandmother-grandchild	No evaluation found

Motion Presence application (Bentley & Metcalf, 2007)	Awareness	Synchronous 2 way.	Romantic partners, friends, family,	One phase involved 3 pairs of spouses/partners/significant others
Intentional Presence Lampshade (Hindus et al., 2001)	Awareness	Synchronous 2 way.	Friends and family	No evaluation found
Hover (Maynes-Aminzade, Tan, Goulding, & Vaucelle, 2002)	Awareness	Synchronous 2 way.	Home or office environment	No evaluation found
Frame (Tollmar et al., 2000)	Awareness	Synchronous 1 way.	Romantic partners	Yes, eight rapid ethnographic studies were performed (in two series of four families each)
Family Digital Assistant (Kjeldskov et al., 2004)	Awareness	Asynchronous multi-way	Families	Yes, 6 cultural probes with a series of contextual interviews
Emotional Environments (Li & Jianting, 2009)	Awareness	Synchronous 2 way.	Romantic partners	No evaluation found
DigitalSelves (Grivas, 2006)	Awareness	Synchronous 2 way.	Romantic partners	No evaluation found
Digital Family Portraits	Awareness, Memories	Asynchronous 1 way	Families	Field trial with grandmother and grandchildren
Curtain Intentional Presence Device (Hindus et al., 2001)	Awareness, Expressivity	Asynchronous 1 way	Not specified	Yes, 2-hour long focus groups of 10 women
Coffee Aroma Generator (Siio et al., 2003)	Awareness	Synchronous 1 way.	Office workers	10 subjects interviewed after 16 weeks
Chime (Dey & de Guzman, 2006)	Awareness	Synchronous 1 way.	Romantic partners	No evaluation found

BuddyClock (Kim, Kientz, Patel, & Abowd, 2008)	Awareness	Synchronous 2 way.	Romantic partners	Yes, pilot study for 3 weeks
Bed (Dodge, 1997)	Awareness, Expressivity	Synchronous 2 way.	Romantic partners	No evaluation found
AugmentedMirror (Dey & de Guzman, 2006)	Awareness, Expressivity	Synchronous 1 way.	More than casual acquaintances	Field study with 9 participants
AROMA (Pedersen, 1998)	Awareness	Synchronous 1 way.	Office and home settings	No evaluation found
AmbientROOM (Ishii et al., 1998)	Awareness, Expressivity	Synchronous 1 way.	Not mentioned	No evaluation found
Ambient Social TV 2 (Harboe et al., 2008)	Awareness	Synchronous 1 way.	Families	10 households in 2 week in-home trials
CastAway (McGill et al., 2016)	Awareness, Joint Action	Synchronous 2 way.	Romantic partners	A laboratory study of 12 pairs
Forget me not flowers (Wallbaum, Timmermann, Heuten, & Boll, 2015)	Awareness, Expressivity	Synchronous 1 way.	Patience in hospitals and relatives	No evaluation found
CoupleVIBE (Bales et al., 2011)	Awareness	Synchronous 2 way	Romantic partners	Four week study with 7 Romantic partners
POKE (Park et al., 2013)	Expressivity, Physicalness	Synchronous 2 way	Romantic partners	One month study with 3 Romantic partners
Wayve, Shades of lightweight (Lindley, 2012)	Expressivity, Note sharing	Asynchronous	Older adult and their family	No evaluation found
Shake-a-Memory Calendar (Kelly et al., 2017)	Memories	Synchronous, 2-way	family and friends	No evaluation found
Craft Box (Kelly et al., 2017)	Expressivity, Gift Giving	Synchronous, 2 way	family and friends	No evaluation found

Bench(Dunne & Raby, 1994)		Synchronous (One as well as two way)	Strangers	No evaluation found
MessageProbe (O'Brien & Mueller, 2006)	Expressivity-note sharing	Synchronous	Families	Field studies
VideoProbe	Expressivity-note sharing	Synchronous	Families	Field studies
Magic box (Davis et al., 2008)	Joint action	asynchronous	Grandparent and grandchildren	Cultural probes with 6 families over 2 weeks period
Tug n'Talk (Adcock, Boch, Harden, Harry, & Poblano, 2007)	Physicalness	Synchronous, 2 way	Not specified	No evaluation found
weConnect (Milic-Frayling, Hicks, Jones, & Costello, 2008)	Expressivity	Synchronous	Close relationships	Field study with 15 users for 2 weeks with early prototype

9 Appendix: B

9.1 Ethics form for the *SmartLamp* study

STAFF ☐ PhD STUDENT ■	
Title of Project (max 15 words)	Measuring the effectiveness of Internet of Things (IoT) objects to bring social presence and closeness in distant family relationships
Name of applicant(s)	Bhagyashree Patil
Contact email for applicant(s)	Bp397@bath.ac.uk
Name of supervisor or lead researcher (for PhD research)	Professor Danae Stanton Fraser
Contact email for supervisor	d.stantonfraser@bath.ac.uk
Proposed start date:	10/03/2015
Date of this application:	24/02/2014
Funding body (if relevant)	

PREVIOUS APPROVAL

1. Has this proposal had (or is it awaiting) ethical approval from anywhere else?

YES: Approved	YES: Awaiting approval	NO: not applicable
☐	☐	■

If you answered YES: Please state which ethics body, you received (or are awaiting) Ethical Approval

from: ----------

N.B. If you have already received ethical approval from another body please attach a copy of your ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

NHS BASED PROJECTS

2. If your proposed project is based in the NHS, does it require:

	Yes: Approved	Yes: Awaiting approval	No: not applicable
a. Full NHS ethical approval?	☐	☐	☐
b. Research and Development approval?	☐	☐	☐

If you have already received ethical approval please attach a copy of your NHS ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

N.B. If you are awaiting full NHS ethical approval or R&D approval. Please refer to the guidance on how to proceed.

DESCRIPTION OF RESEARCH

Please provide all further information under the following headings in the boxes provided. Please refer to the guidance document for advice on how to fill in each section.

3. Who will be recruited to participate in the research?

All the participants will be over 18 years of age. Participants will be a minimum of 4-8 pairs of mother/father daughter/son, sibling partnerships living in different cities (who consider themselves in a distant relationship). They are expected to be fairly regularly in touch contacting minimum once a week via some medium.

4. How many participants will be recruited?

4-8 pairs of participants.

5. How will participants be recruited?

This is a pilot study, It will be iteratively designed with a first study using the technology between the CREATE lab and the Pervasive media studio and then participants will be sourced from word of mouth through the Pervasive media studio, Bristol and the CREATE Lab at the University of Bath. I am a member of both of these labs therefore know some of these participants although they do not

know the details of the study therefore their opinions are not biased.

6. Are there any potential participants who will be excluded? If so, what are the exclusion criteria?
Participants under 18 years of age will be excluded. Also participants who do not own a smartphone or do not have Wi-Fi system in their home will be excluded.

7. Where will the research take place?

At the participant's home, workplace or any other desired placed that participant will find meaningful to set up the device.

8. How will informed consent be obtained from all participants or their parents/guardians prior to individuals entering the study?
Participants will be given an information sheet to read prior to the study, after which they will be given the opportunity to ask questions about the study and then asked to sign a consent form. Two copies of the consent form will be obtained, one of which will be given to participant to take home and another will be kept by the researcher. These copies will be kept separate from the research data. The copies of these documents are attached.

9. Will the study actively involve deceiving the participants?

No. There is no deception involved in this study.

10. Will participants be made aware they can drop out of the research study at any time without having to give a reason for doing so?
Yes.
Protocol if one dyed withdraws from the study:

The participants are asked to contact the researcher if they wish to withdraw from the study. In the unlikely event that this happens, the researcher will then ask the participant if he/she has communicated their wish to withdraw with the other participant, if they have, then both will be thanked for their participation and withdrawn from the study. In the case that the person has not communicated with the other participant that they want to withdraw from the study, then the researcher will request them to do so. If they do not wish to communicate this with the other participant, the researcher will contact the other participant to discreetly notify them that we have received all the data that we need. They both will be thanked for their participation and will be withdrawn from the study together.

11. Outline the design of the research study and list the procedures to which the participants will be subjected, how much time (roughly) it will take for participants to take part in the study, any questionnaires administered and an interview schedule. (maximum 300 words)

The study will be conducted over a one-month period. The study consists of 3 phases. Phase 1 will

run through the first week where the communication habits of participants will be observed via a diary study. Participants will need to fill in a part of a diary consisting of a social presence questionnaire after each communication episode. It will take them a maximum of 2-3 minutes each time. At the end of the day they be asked to fill the last part including the Inclusion of others in the self (IOS) questionnaire to record their daily closeness rating.
Phase 2 will consist of 2 weeks where the system consisting of smart lights will be installed at the participant's home/office. They will be asked to repeat the process of the diary study only when they will be using the light system. Phase 3 will consist of the last week of study where the system will be un-installed from participant's space. They will then continue with the diary study for 1 week. This is to observe if there is any change in the communication habits and felt social presence of participants. Semi structured interviews will be conducted at the end of the phase 2 and the end of the entire study to gather qualitative data which will be either conducted face to face or via Skype with their distant partner. The interviews will take a maximum of 15 minutes.

12. Describe potential risks to participants (physical, psychological, legal, social) arising from these procedures.

The system we have designed is an additional communication device. All participants will be made aware that this is a prototype system and there are possibilities that it may not always be accurate. If at any time the lamp is not switched on as they expect not to rely on *Smart lamp* system to know the whereabouts of their son/daughter/sibling. This has been included on the information sheet and I will be communicating this to both participants verbally. All participants will be technologically able and aware that they are testing a prototype device.

Some participant might have privacy concerns about their family knowing their whereabouts. This will be clearly communicated to participants verbally, on the information sheet and on the consent form before signing. If they are happy with their family knowing about their whereabouts, then only they will be asked to participate in the study. Participating in this study does not involve any risks outside of those encountered in the participants' everyday life.
The devices used in this experiment has been PAT tested and is a commercially available product.

During the study, if the participant who has the lamp, turns the lamp off for any reason, the other participant will be unaware of this, unless they communicate by another medium about their interaction. Therefore, this will not cause any distress between participants. We will not be suggesting that participants share diaries with each other. All their data will be kept confidential.

Participants who take part in this study will be choosing to communicate with one another. We anticipate that the participants that take part will be in a good relationship, however if the researcher detects any interpersonal problems in their relationship then these will be kept confidential. Please note that all participants at this point will be from a pool of participants where one of the pairs is part of the research environment. If in the unlikely event the ambient communication using the lamp appears to be causing any relationship problems the participants will be tactfully withdrawn. In the unlikely event this is extreme they will be kindly directed to seek professional help.

13. How will participants be debriefed?
All participants will be given a debriefing sheet consisting of information about the study, the kind of data we are collecting and how it will be stored and used. This will also be communicated verbally. They will receive emails a couple of times in the day to remind them of filling out the diary. They can opt to stop the emails.

14. How will confidentiality and security of personal data relating to your participants be maintained?
Participants will be informed about the type of data collected and it will be made anonymous so that their identity cannot be traced back to the individuals. The data will be stored securely, and it will be made clear to the participant that the data might be published to present results after it is made anonymous.

15. Will the participants be audio-taped or video-taped?
The semi-structured interviews conducted after phase 2 and phase 3 will be audio recorded with the consent of the participants.

16. Is any reimbursement of expenses or other payment to be made to participants?
Participants will be reimbursed for the return shipping charges of the equipment (Belkin WeMo switch).

17. Any other relevant information?

Participants will be advised to contact the researcher if they have any queries or problems during the study and the constant support throughout the study will be provided.

18. Checklist: have you attached?

	YES	NO	N/A
Evidence of ethical approval from another body	☐	☐	■
Information sheets	■	☐	☐
Consent forms	■	☐	☐
Debrief sheets	■	☐	☐
Interview schedules	■	☐	☐
Questionnaire measures	■	☐	☐

Keep in mind that if any of the above information is missing, your application will be returned to you without a decision.

Please submit **two hard copies** of this form, including all attachments, to the designated ethics essay box in the department of Psychology foyer in 2 South across from the main office.

Please note that failure to include any relevant section or signature may result in your form being rejected.

Signature of applicant	Print Name Bhagyashree Patil	Date 24/02/2015

By signing and submitting the form, you are agreeing with the following statement:
'I am familiar with the BPS guidelines for ethical practices in psychology research and I have discussed the ethical aspects of the proposed project with my supervisor(s) and/or the other researchers involved in the project.'

Signature of lead researcher or supervisor (if different from applicant)	Print Name	Date 28/04/2015

By signing you are agreeing that you take joint responsibility for the application and conduct of the research.

9.2 Information Sheet the participants of the *SmartLamp*

Study Title: Evaluation of *Smart lamp* system

Thank you for agreeing to take part in this study; which explores how people use the system called *Smart lamp* in long-distance family relationships. The purpose of this study is to understand the daily communication habits of close family members such as mother/father, son/daughter, and sibling partnerships that live far from each other (who consider themselves in a distant relationships).

The study will involve

- Filling a daily diary.
- Attending two brief interviews after the third and fourth weeks of the study.

The *Smart lamp* system is intended to provide additional communication channel to create awareness of your study partner in your life when he/she arrives at a particular space. This space could be home, workplace or any other meaningful space that is chosen by your study partner**.** The *smart lamp* system consists of a commercially available smart switch, a small lamp and a smartphone. The device will be activated by your study partner's Smartphone. The details of how the system works are explained below. The lamp is activated when your study partner arrives at a pre-decided space that is meaningful to him/her and is deactivated when he/she leaves that space.

How the *Smart lamp* system works:

The system uses a smart wireless switch, which is connected to the Wi-Fi of the users' home and can be switched on and off using the mobile application. If you decide to participate in this study, we will ask you to install this switch at your house. The switch pack contains an instruction sheet of how to install the switch however if you do experience problems or need guidance to install the switch, please get in touch with the researcher. More information about the switch is available here- http://www.belkin.com/uk/p/P-F7C027/

Guide how to install it is available here- http://cc.cnetcontent.com/inlinecontent/production/fa/faed707b2c50/cnet_08a6_doc.pdf). If you have a small lamp, you could go ahead and plug that into the switch. In a case if you don't own a small lamp, the researcher will provide you one. The switch will use your home Wi-Fi connection to connect with the internet. Your study partner will have a Smartphone with the sufficient internet data plan to last for the duration of study. He/she will need to install smart phone app called *If this then that* (IFTTT) and configure it with the switch provided to you. The researcher will guide through each step to configure it. When your study partner arrives at a pre decided space, IFTTT detects the location and switches the lamp on at your home. We expect you to be fairly regularly in touch contacting minimum once a week via some medium. We would ask you to keep a

diary record of all your contact with your study partner. A diary and pen will be provided to you to fill in your response.

Duration

The study will run for 4 weeks, and will be divided into three phases:

(i) Phase One (Week 1) will consist of keeping a daily record of communications with your study partner using a diary provided to you; whenever you contact or are contacted by your study partner in any way; please fill in a record in the diary provided to you.

(ii) Phase Two (Weeks 2-3): During the second phase we are interested to see how *Smart lamp* system is integrated in your daily communication routine. **You are free to use the system however way you like.** For example, you are free to switch the light off (using a button on the switch) after it is switched on when your study partner comes home. **You will need to leave the main power source on at all times.** Please make note of all the actions you take with the system.

At the end of Phase Two, you will be invited to attend a short interview via Skype or telephone, which will take maximum of 15 minutes.

(ii) During Phase Three (Week 4) we will ask you to stop using the *Smart lamp* system and continue with your normal communication routine. You will be asked to return the lamp and the switch at this point. You will be asked to continue to fill the diary until the end of Week 4. At the end of Week 4 we will invite you to attend the final interview using Skype or telephone, which will take a maximum of 15 minutes. At the end we will ask you to return the diaries and any other material provided to you. You could either mail it to the address provided by researcher or if you live close to Bath or Bristol then you could return it in person. The cost of return shipping will be reimbursed.

Diary Management Duties

During this four-week study, we will provide you with a pen and a diary, which you will be asked to fill in each day. The diary is divided into two sections:

(i) Section 1 contains few questions that you would be asked to fill as soon as possible after every time you contact or are contacted by your study partner.

(ii) Section 2 is to be filled at the end of the day, which also contains few questions. More details of this are available on the diary instruction sheet.

Daily reminders will be sent via email; however, you may opt out of receiving these reminders.

Please note that this is a prototype device and may not always be accurate. It might take several minutes for the lamp to switch on after your study partner

arrives at the pre-decided space. We would strongly advise you contact your study partner if you feel worried about their whereabouts.

The researcher will guide you through what needs to be done at each stage. Please feel free to contact researcher and ask any questions at any time during the study. The details of researcher are at the end of this document.

Your privacy

At all times during this study your anonymity will be preserved. Your information will be stored against a random identifier rather than your name or details. Your name will only exist on the consent form, which will not be digitized and will be stored securely in a locked cupboard, according to University confidentiality procedures.

Your audio interview will only be available to the researcher and their supervisors and will also be kept secure. The results may be published in anonymous form.

Voluntary participation:

Your participation is completely voluntary. Participating in this study does not involve any risks outside of those encountered in your everyday life. You have the right to withdraw from the study at any time without consequence. If you do want to withdraw from the study, we would request you to contact researcher immediately.

Contact details

Researcher: Bhagy Patil.
Email: b.patil@bath.ac.uk
Contact number: 01225384280

9.3 Consent form for participants of the *SmartLamp* study

Study Title: Evaluation of *Smart Lamp* system

Please read the information sheet and consent form carefully before you decide to participate in this study

Agreement

By signing this sheet I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. I understand that my participation is voluntary and I have right to withdraw any time during the study. I understand that I can choose another family member for study if my current study partner decides to withdraw or else we both withdraw from the study together if one decides to stop. I understand that my data collected in this study will be used in scientific publications in anonymized form. I will return the material provided to me at the end of this study. I voluntarily agree to participate in the procedure and have received a copy of this description and the information sheet.

Name of Participant Date Signature

Email

Please contact the researcher if you need any support regarding study, experience any problems with equipment or have any queries.

Researcher: Bhagyashree (Bhagy) Patil, Department of Psychology, University of Bath, Bath, BA2 7AY.

Email: b.patil@bath.ac.uk

Contact number: 01225384280

9.4 Pre-study questionnaire for the *SmartLamp* study

1. Are you male or female?

☐ Male

☐ Female

☐ Prefer not to say

2. What is your age? _____

3. What is your occupation? _____

4. Please state your role

☐ Parent

☐ Son/daughter

☐ Siblings

5. Are you okay with receiving daily emails to remind you to fill the diary?

☐ Yes ☐ No

6. Have you received the WeMo switch with this study?

☐ Yes ☐ No

7. Have you received the lamp with this study?

☐ Yes ☐ No

8. How many times a week do you contact each other?

☐ Less than once a week ☐ once a week ☐ every other day

☐ Once a day ☐ multiple times a day

For participant with lamp:

Do you own a small light lamp?

☐ Yes ☐ No

Do you have a Wi-Fi system at your home?

☐ Yes ☐ No

For second participant (the one who is choosing the space):

Do you own a smart phone?

☐ Yes ☐ No

Which smart phone do you use?

☐ iPhone ☐ Android ☐ Windows

9.5 Diary pages

This diary has two sections:

Section 1

This section is intended to record your communication with your study partner each time you contact (or are contacted by) your study partner.

Every time you communicate with your study partner, please fill in the new record. In week two and three, the *SmartLamp* will switch on when your study partner arrives at a certain place and will switch off when he/she leaves that place. **Please fill in a new record when the lamp switches on/off.**

There are few simple questions about the contact. After that there is a table that consists of nine items. Please choose how you would best describe your communication with your study partner at that instance. Please rate how you would describe the contact.

Section 2

This section is intended to record how close you feel to your study partner. Please fill this part in the evening, preferably at the same time each day. Please circle the diagram which best represents how close you feel to your study partner. The circle tagged as self refers to you and the other refers to your study partner.

At the end of the section 2 there is a free form component where we would like you to write any comments you have about your daily communication, *Smart lamp* system, whether you used it or not, what impact did it have on your daily communication habit.

If you have any questions, please contact:

Researcher: Bhagyashree (Bhagy) Patil, Department of Psychology, University of Bath, Bath, BA2 7AY.

Email: b.patil@bath.ac.uk **Contact number: 01225384280**

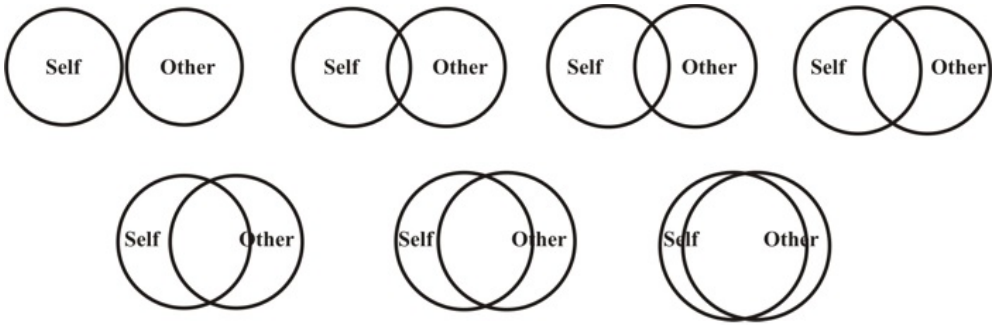
Section 1

Every time you communicate with your study partner, please fill in the new record.
A. How did you contact (or were contacted by) your study partner today? (Choose one)

- Face to face
- Whatsapp /Viber
- Telephone
- SMS
- Skype/Facetime with audio & Video
- Skype/Facetime with only audio
- Email
- Lamp
- Letter/ Card
- Facebook post/comments
- Facebook messenger
- Other

Section 2: WEEK 2 DAY 1

How close do you feel to your study partner today?



Did the *Smart lamp* system triggered today? (Did the lamp switch on?)

□ Yes □ No

How many times did it trigger?

□ 1 time □ 2 times □3 times □ 4 times □ 5 or more

How did you feel when the lamp was switched on?

How do you feel about your study partner today? If you communicated with your study partner today, how did it make you feel? Did the feeling last all day? Was there anything unusual about your communication today?

---

10 Appendix: C

10.1 Graphs for variables reported in Chapter 4

10.1.1 Graphs for adult children survey:

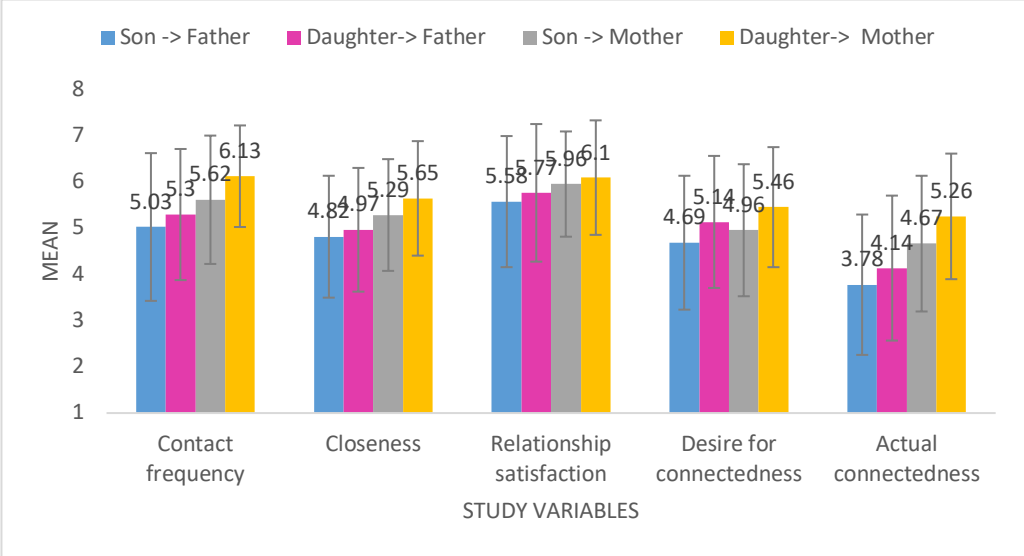


Figure 28. Effect of gender- Mean and SD based on relationship type

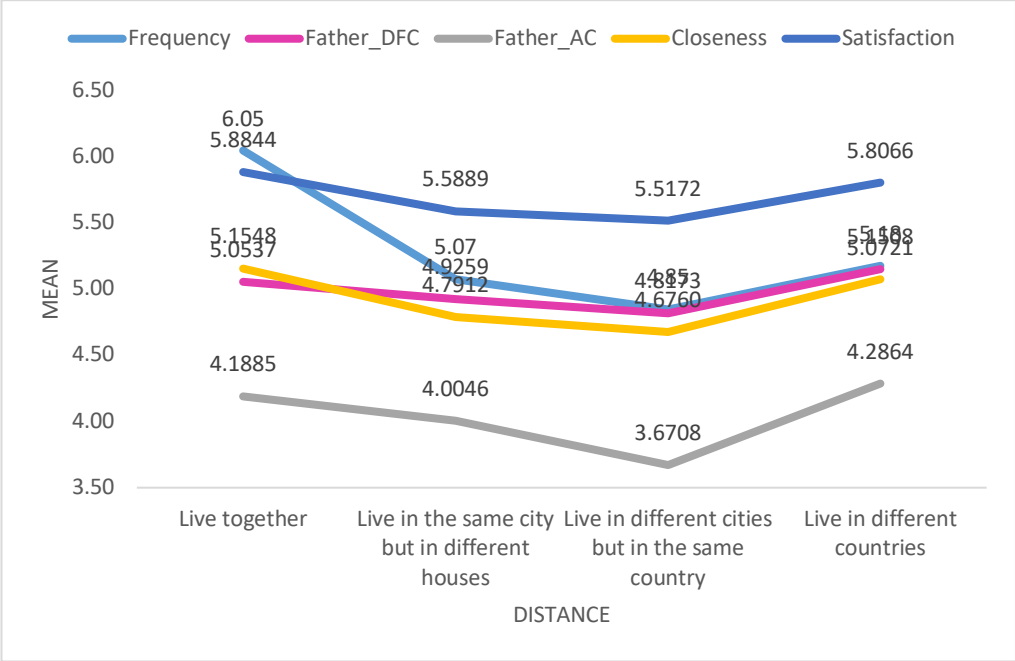


Figure 29. Variation of variables with distance from father

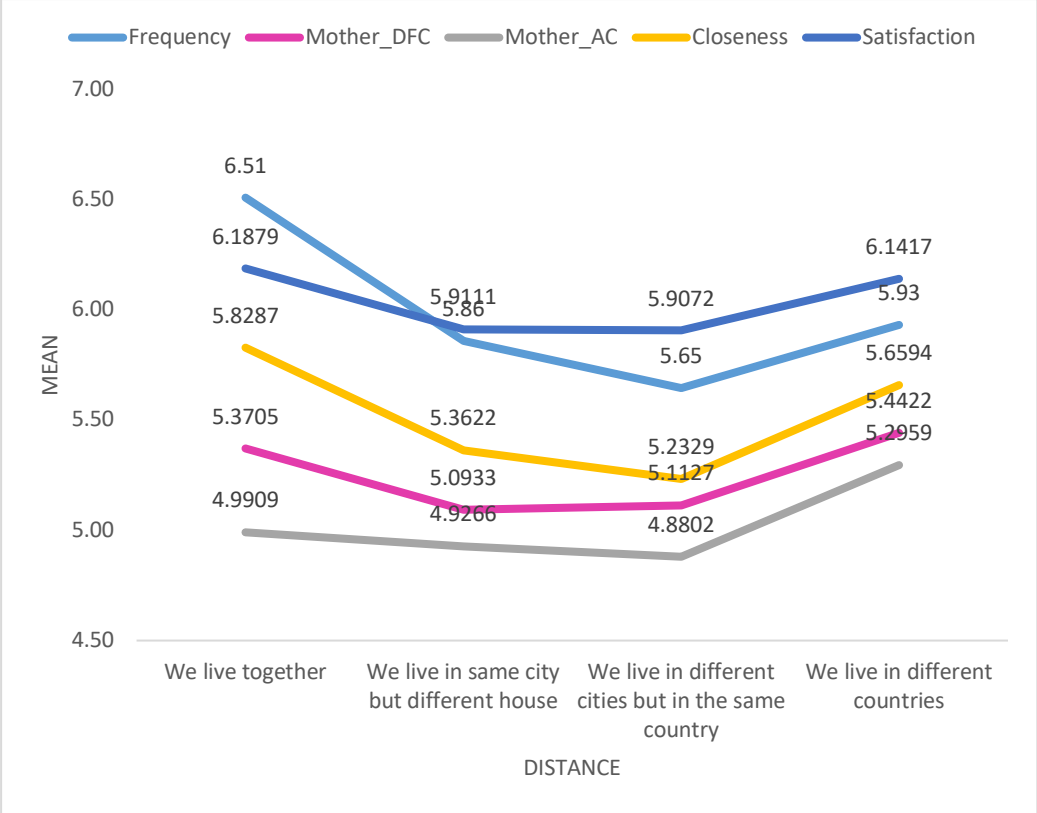


Figure 30. Variation of variables with distance from mother

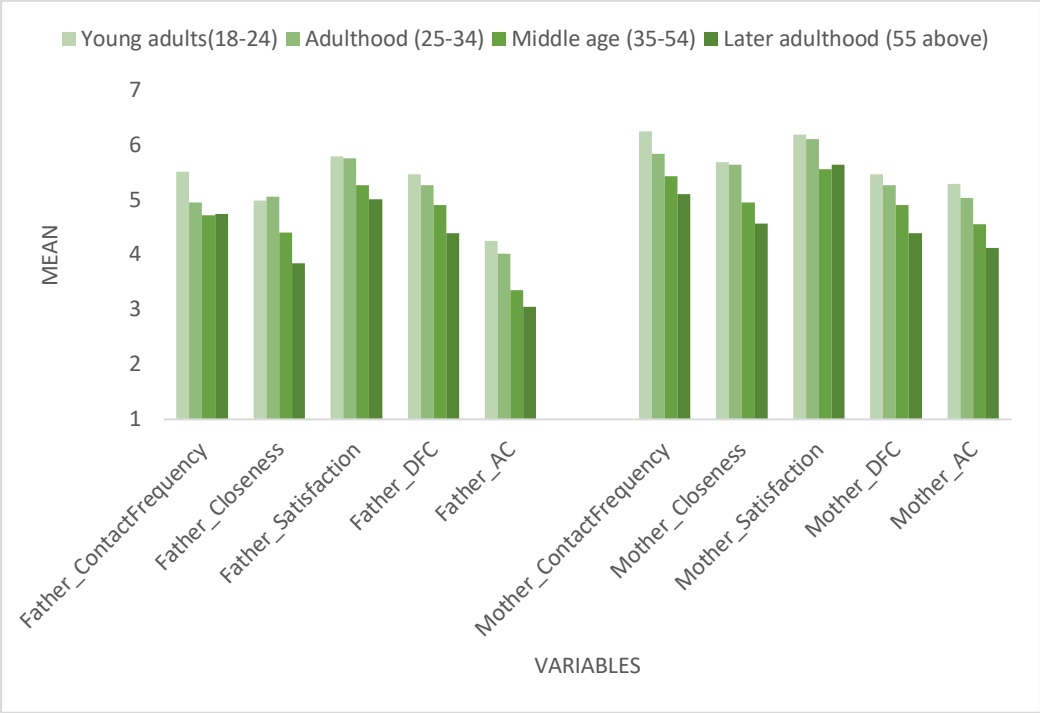


Figure 31. Mean difference based on adult-child's age

10.1.2 Graphs for parent's survey

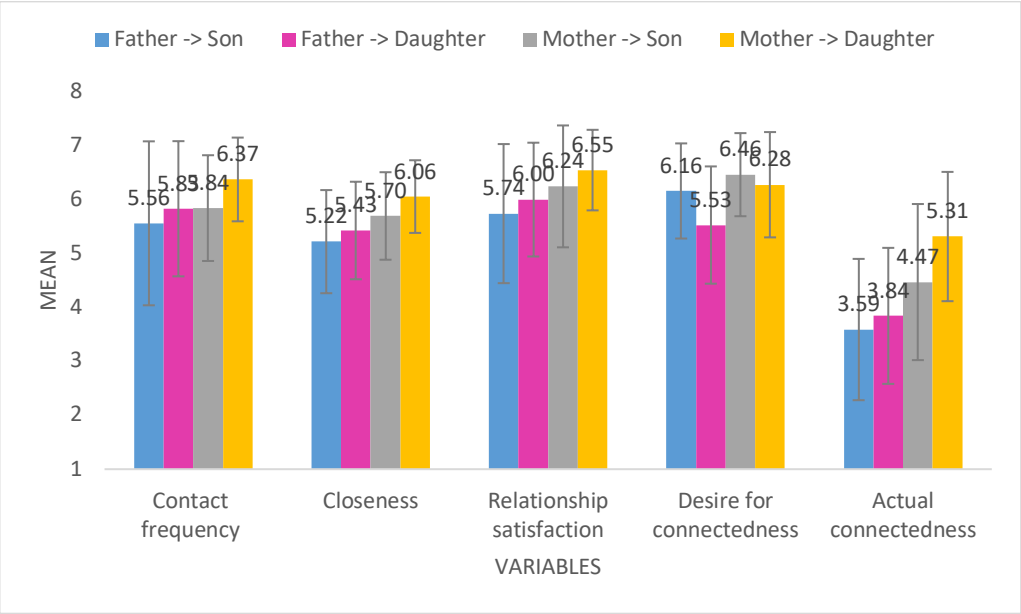


Figure 32. Mean and SD based on relationship type

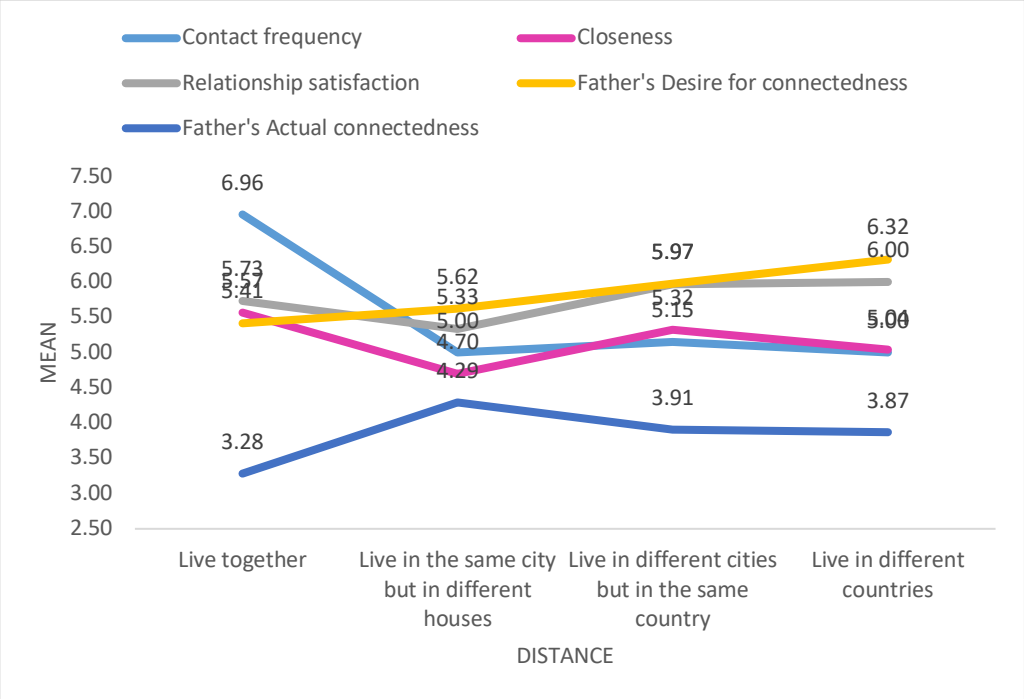


Figure 33. Effect of distance on fathers' feelings towards their adult children

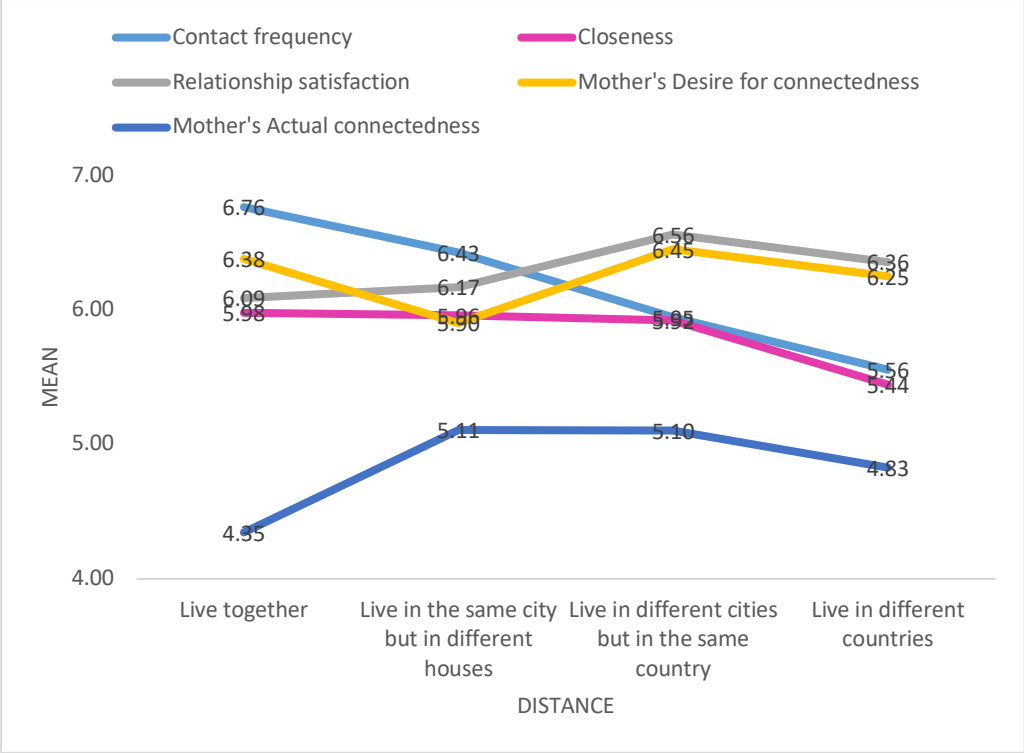


Figure 34. Effect of distance of mothers from their adult children

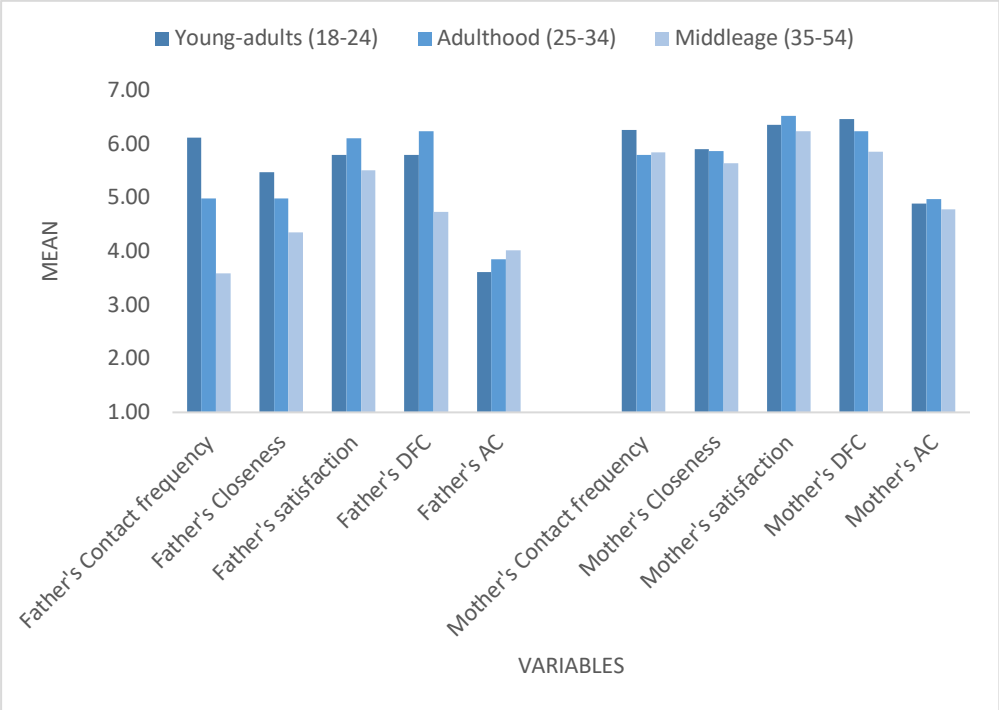


Figure 35. Effect of adult child's age on parents' variable

10.2 Ethics form for online questionnaire study

Department of Psychology Ethical Approval Form for STAFF

STAFF ☐	PhD STUDENT ■
Title of Project (max 15 words)	Information and communication technologies use by Parent-Adult children to maintain contact over distance
Name of applicant(s)	Bhagyashree Patil
Contact email for applicant(s)	Bp397@bath.ac.uk
Name of supervisor or lead researcher (for PhD research)	Dr. Jeff Gavin Professor Danae Stanton Fraser
Contact email for supervisor	j.gavin@bath.ac.uk d.stantonfraser@bath.ac.uk
Proposed start date:	07/07/2016
Date of this application:	28/06/2016
Funding body (if relevant)	

PREVIOUS APPROVAL

1. Has this proposal had (or is it awaiting) ethical approval from anywhere else?

YES: Approved	YES: Awaiting approval	NO: not applicable
☐	☐	■

If you answered YES: Please state which ethics body you received (or are awaiting) Ethical Approval

from: ----------

N.B. If you have already received ethical approval from another body please attach a copy of your ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

NHS BASED PROJECTS

2. If your proposed project is based in the NHS, does it require:

	Yes: Approved	Yes: Awaiting approval	No: not applicable
a. Full NHS ethical approval?	☐	☐	■
b. Research and Development approval?	☐	☐	■

If you have already received ethical approval please attach a copy of your NHS ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

N.B. If you are awaiting full NHS ethical approval or R&D approval. Please refer to the guidance on how to proceed.

DESCRIPTION OF RESEARCH

Please provide all further information under the following headings in the boxes provided. Please refer to the guidance document for advice on how to fill in each section.

19. Background and aims of the research (maximum 300 words)

Many people live far from their family at least some part of their lives. Distant relationships between families are most common as children move out of the house at a certain age to start independent lives. Research shows that adult child-parent relationships extend into adulthood (Mancini & Blieszner, 1989). 80% of people report being close to their parents (Taylor, Funk, Craighill, & Kennedy, 2006). Intimacy and feeling of closeness with family members plays a very important role in people's lives and has an impact on their well-being (Reis, Clark, & Holmes, 2004). Previous research done on communication technologies has found that people like to stay connected to their loved ones (Chen, Forlizzi, & Jennings, 2006). With the help of information and communication technology (ICTs) it is now possible to stay connected and communicate with family members. The contact using information and communication technology creates the feeling of connectedness (Kuwabara et al, 2002). Connectedness refers to phenomenon whereby persons desire constant sense of connection with another person even when they are physically separated (Rettie, 2003). Qualitative research has indicated that connectedness has an effect on family relationships (Chen & Katz, 2009) however it is not known if it affects closeness in the relationship. Parents and adult children relationship are especially understudied (Schon, 2014). Research has been done to investigate how new information communication technologies affect peer relationships and parents' communication with their young children however how ICTs influence parent–adult child relationships is less clear. This study aims at investigating how adult children and their parents use ICT to connect with each other to maintain relationship. I aim to explore if there is difference between desired connectedness and actual connectedness and if it affects relationship closeness and satisfaction between adult children-parents.

20. Who will be recruited to participate in the research?
People over 18 years that have either mother or father alive that they maintain contact with.
People that have a child over 18 years old.

21. How many participants will be recruited?
As many as possible but minimum 300.
As many as possible but minimum 100 which gives margin of error of 10%.

22. How will participants be recruited?
Using social media, notice board, and word of mouth.

23. Are there any potential participants who will be excluded? If so, what are the exclusion criteria?
Children under 18 years are omitted. People that do not have any contact with either of their parents are omitted as well.
People that do not have children over 18 years old are excluded. People that do not have any contact with either of their children are omitted as well.

24. Where will the research take place?
Online survey filled anywhere anytime

25. How will informed consent be obtained from all participants or their parents/guardians prior to

individuals entering the study?

Participants will be fully informed about the nature and purpose of the study and will be asked whether they consent to participate before entering the survey. They can stop survey any time during the study without
any consequences

26. Will the study actively involve deceiving the participants?

No. There is no deception involved in this study.

27. Will participants be made aware they can drop out of the research study at any time without having to give a reason for doing so?

Yes. This is mentioned in the consent form before the survey begins

28. Outline the design of the research study and list the procedures to which the participants will be subjected, how much time (roughly) it will take for participants to take part in the study, any questionnaires administered and an interview schedule. (maximum 300 words)

Participants will be invited to take part in the online survey and once they click on the survey link, they will be taken to information sheet. They will be then asked to give consent if they are happy with the information. After they give consent, the survey will begin which will take about 15 min to complete.

Participants will be asked to provide some basic demographic information (age, sex, country of residence etc.) and to indicate their communication competence.

They will then asked to fill in various standardised measures to understand their use of ICT with their son/daughter. Following variables are measured using the standardised scale,

- Demographic information
- Communication Repertoire Size
- Communication Frequency
- Desired connectedness
- Actual Connectedness
- Closeness
- Relationship satisfaction
- Some open form questions

After they complete survey, they can input their email if they wish to take part in the prize draw but this is optional. They will be then debriefed and thanked for their participation.

29. Describe potential risks to participants (physical, psychological, legal, social) arising from these procedures.

No known physical, psychological, legal, social risks

30. How will participants be debriefed?

At the end of the survey, participants will be given debriefed information

31. How will confidentiality and security of personal data relating to your participants be maintained?

Participants will not be asked for their names or contact information therefore their participation is completely anonymous. Responses will be stored securely on an external hard disk.

Submitted e-mail addresses (from those respondents who wish to take part in the prize draw) will be extracted from the survey data set and saved in a separate spreadsheet to avoid any linkage to participants' survey responses. After the winners of the prize draw have been notified and received their vouchers, the file including all e-mail addresses will be deleted.
32. Will the participants be audio-taped or video-taped? No.
33. Is any reimbursement of expenses or other payment to be made to participants? Participants will have the opportunity to enter a prize draw for one £50 prize by entering their contact information (e-mail).
34. Any other relevant information? Participants will be advised to contact the researcher if they have any queries or problems during the study and the constant support throughout the study will be provided.
35. Checklist: have you attached?

	YES	NO	N/A
Evidence of ethical approval from another body	☐	☐	■
Information sheets	■	☐	☐
Consent forms	■	☐	☐
Debrief sheets[	■	☐	☐
Interview schedules	■	☐	☐
Questionnaire measures	■	☐	☐

Keep in mind that if any of the above information is missing, your application will be returned to you without a decision.

Please submit **two hard copies** of this form, including all attachments, to the designated ethics essay box in the department of Psychology foyer in 2 South across from the main office.

Please note that failure to include any relevant section or signature may result in your form being rejected.

Signature of applicant	Print Name Bhagyashree Patil	Date 28/06/2016

By signing and submitting the form, you are agreeing with the following statement:
'I am familiar with the BPS guidelines for ethical practices in psychology research and I have discussed the ethical aspects of the proposed project with my supervisor(s) and/or the other researchers involved in the project.'

Signature of lead researcher or supervisor (if different from applicant)	Print Name Jeff Gavin	Date 27/6/16

By signing you are agreeing that you take joint responsibility for the application and conduct of the research.

10.3 Information Sheet for online survey study

Study Title:
Parent's technology use to maintain contact with their adult children.

You are invited to take part in the study, which explores the how people use the technologies to connect with their adult children. The study involves filling an online questionnaire that asks you question about your contact with your son/daughter.
This study has ethics approval of department of psychology of University of Bath. Ethics reference number 16-181.
Your participation is completely anonymous and completely voluntary. There are no known risks of participating in this study. You have the right to withdraw from the study at any time without consequence. Please contact the researcher at following email id if you want more information about the study or if you are interested in the outcome of the research. Please close this window if you do want to withdraw from the study. Please press continue to go to the survey.

Contact details
Researcher: Bhagy Patil.
Email:
b.patil@bath.ac.uk

10.4 Online Consent Form

You are invited to take part in a research survey about technologies used by parents and their adult children to connect with each other. Your participation will require approximately 10 minutes and is completed online at your computer. There are no known risks or discomforts associated with this survey. Your participation will help us understand which technologies parents use to connect with their adult son/daughter. You will be entered into £50 cash prize draw after the completion of the survey.

Taking part in this study is completely anonymous. Your participation is voluntary. You can withdraw at any time. Your responses will be kept strictly confidential. We will not ask your name or any other individual information by which you could be identified. If you have any questions, please contact researcher Bhagy Patil at b.patil@bath.ac.uk.

□ Please tick this box to indicate you are have read the information displayed above and consent to participate.

10.5 Questionnairs used in the study

10.5.1 Demographic questionnaire

Are you male or female?
- ❍ Male
- ❍ Female
- ❍ Prefer not to say

What is your age?
- ❍ 30 - 34
- ❍ 35 - 44
- ❍ 45 - 54
- ❍ 55 - 64
- ❍ 65 - 74
- ❍ 75 - 84
- ❍ 85 or older

Which country do you currently live in?
(Drop down list of countries.)

Which would you describe as your ethnic origin?
- ❍ Caucasian
- ❍ Latino/Hispanic
- ❍ Middle Eastern
- ❍ African
- ❍ Caribbean
- ❍ South Asian
- ❍ East Asian
- ❍ Mixed
- ❍ Other

Which of the following best describes your current occupation?
- ❍ Full time student
- ❍ In employment (part or full time)
- ❍ Looking after the home / family
- ❍ Not eligible for employment
- ❍ Retired
- ❍ Self-employed
- ❍ Unemployed

Which mobile phone do you use?
- ❍ Smart phone (Android, iPhone, Windows)

- ❍ Older generation mobile Phone (For example flip-phone, old Nokia, old Sony Ericsson)
- ❍ I don't use a mobile phone

10.5.2 Communication repertoire size

Please check the box next to all the technologies that you use regularly (at least once a month) to communicate with other people. (Please choose as many as you use every month)

- ❑ Calling via Land line telephone
- ❑ Calling via Mobile phone
- ❑ Instant messaging via Mobile phone or Computer (e.g. WhatsApp, Viber, Facebook messenger, IMO, Telegram, Snapchat)
- ❑ Text messaging (SMS/MMS)
- ❑ Video & audio calls through programs such as Skype, FaceTime, ooVoo, or Tango
- ❑ Audio only calls through programs such as Skype, FaceTime, ooVoo, or Tango
- ❑ Email (via computer or smart phone)
- ❑ Social networking websites such as Facebook, Twitter, Instagram, Flickr, Google+, LinkedIn or other similar sites
- ❑ File sharing such as Dropbox, Google Docs, etc. (don't check this box if you only file share with yourself, you must use it to file share with other people).
- ❑ Sharing videos online, such as through YouTube, Vimeo, Dailymotion, etc.
- ❑ Family mobile apps for location sharing
- ❑ Shared online calendar such as Google Calendar, Cozi Family Organizer, Wiggio, or Keep and Share Calendar (don't check this box if you only use the calendar with yourself, you must use it to communicate with other people)
- ❑ Letters/ Cards
- ❑ Other 1 _____
- ❑ Other 2 _____

QUESTIONS ABOUT YOUR SON/DAUGHTER

If you have multiple children that are over 18 years then please feel free to choose either one of them and answer the questions in this section **related to only him/her.** You will have opportunity to answer questions for your other children at the end of this section. Here 'Son/Daughter' refers to a person that you consider as your children. It could be your Stepchildren, Biological children, Foster children or adopted children. Please note that it does not refer to grandchildren, nephews, nieces or godchildren.

Are you filling in this questionnaire for your son or daughter?

- ❍ Son
- ❍ Daughter

Do you have contact with your son/daughter at least once a year?

- ❍ Yes
- ❍ No

Please select the current age of your son/daughter. If you are unsure, make a guess.

- ❍ 18 – 24
- ❍ 25 – 29
- ❍ 30 - 34
- ❍ 35 - 44
- ❍ 45 - 54
- ❍ 55 - 64
- ❍ 65 - 74

Where does your son/daughter live?

- ❍ We live together
- ❍ We live in the same city but in different houses
- ❍ We live in different cities but in the same country
- ❍ We live in different countries

Which country does your son/daughter lives in?
Drop down list of countries.

How often do you and your son/daughter communicate with each other?

- ❍ Once a year
- ❍ Several times a year
- ❍ Once a month
- ❍ Several times a month
- ❍ Once a week
- ❍ Several times a week
- ❍ Almost daily

Please check the box next to all communication technologies that you and your son/daughter currently use to communicate with each other.

- ❑ Calling via Land line telephone
- ❑ Calling via Mobile phone
- ❑ Instant messaging via Mobile phone or Computer (e.g. WhatsApp, Viber, Facebook messenger, IMO, Telegram, Snapchat)
- ❑ Text messaging (SMS/MMS)
- ❑ Video & audio calls through programs such as Skype, FaceTime, ooVoo, or Tango
- ❑ Audio only calls through programs such as Skype, FaceTime, ooVoo, or Tango
- ❑ Email (via computer or smart phone)
- ❑ Social networking websites such as Facebook, Twitter, Instagram, Flickr, Google+, LinkedIn or other similar sites

- ❑ File sharing such as Dropbox, Google Docs, etc. (don't check this box if you only file share with yourself, you must use it to file share with other people).
- ❑ Sharing videos online, such as through YouTube, Vimeo, Dailymotion, etc.
- ❑ Family mobile apps for location sharing
- ❑ Shared online calendar such as Google Calendar, Cozi Family Organizer, Wiggio, or Keep and Share Calendar (don't check this box if you only use the calendar with yourself, you must use it to communicate with other people)
- ❑ Letters/ Cards
- ❑ Other 1 _____
- ❑ Other 2 _____

10.5.3 Desired connectedness Scale

Developed from Rettie (2003) and Licoppe (2004)

Directions: Indicate your level of agreement with the following statements by clicking the corresponding number.
1 = strongly agree 2 = agree 3 = somewhat agree 4 = neither agree nor disagree 5 = somewhat disagree 6 = disagree 7 = strongly disagree

1. I like when my son/daughter calls and/or message throughout the day mainly just to exchange pleasantries (hello's, goodbye's).
2. I dislike when my son/daughter calls and/or message throughout the day just to maintain contact.
3. I like when my son/daughter call and/or message throughout the day just to reassure me he/she is around.
4. I dislike when my son/daughter calls and/or message throughout the day just to let me know he/she is thinking of me.
5. I like when my son/daughter calls and/or message throughout the day about insignificant things happening in his day just so we feel connected.
6. I dislike when my son/daughter tries to maintain a sense of connection with me throughout the day using calls and/or messages.
7. I like when my son/daughter calls and/or message throughout the day just to keep in touch.
8. I dislike when my son/daughter calls and/or message me throughout the day just to let me know they haven't forgotten about me.

10.5.4 Actual Connectedness Scale

Developed from Rettie (2003) and Licoppe (2004)

Directions: Indicate your level of agreement with the following statements by clicking the corresponding number.
1 = strongly agree 2 = agree 3 = somewhat agree 4 = neither agree nor disagree 5 = somewhat disagree 6 = disagree 7 = strongly disagree

1. My son/daughter calls and/or message throughout the day mainly just to exchange pleasantries (hello's, goodbye's).
2. My son/daughter calls and/or message throughout the day just to maintain contact.
3. My son/daughter call and/or message throughout the day just to reassure me he/she is around.
4. My son/daughter calls and/or message throughout the day just to let me know he/she is thinking of me.
5. My son/daughter calls and/or message throughout the day about insignificant things happening in his day just so we feel connected.
6. My son/daughter tries to maintain a sense of connection with me throughout the day using calls and/or messages.
7. My son/daughter calls and/or message throughout the day just to keep in touch.
8. My son/daughter calls and/or message me throughout the day just to let me know they haven't forgotten about me.

10.5.5 Relationship Satisfaction Scale

(Beatty and Dobos, 1992)

Directions: Please click the circle under the number the best reflects how you feel about your relationship with your son/daughter.

Satisfying	1 2 3 4 5 6 7	Unsatisfying
Fulfilling	1 2 3 4 5 6 7	Unfulfilling
Positive	1 2 3 4 5 6 7	Negative
Rewarding	1 2 3 4 5 6 7	Punishing
Good	1 2 3 4 5 6 7	Bad

10.5.6 The Unidimensional Relationship Closeness Scale (URCS)

Instructions: The following questions refer to your relationship with your son/daughter.

Please think about your relationship with your son/daughter when responding to the following questions.

Please respond to the following statements using this scale:

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

1. My relationship with my son/daughter is close.
2. When we are apart, I miss my son/daughter a great deal.
3. My son/daughter and I disclose important personal things to each other.
4. My son/daughter and I have a strong connection.
5. My son/daughter and I want to spend time together.
6. My son/daughter is a priority in my life.
7. My son/daughter and I do a lot of things together.
9. When I have free time I choose to spend it alone with my son/daughter.
10. I think about my son/daughter a lot.
11. My relationship with my son/daughter is important in my life.
12. I consider my son/daughter when making important decisions.

10.5.7 Open ended questionnaire

Please choose what you feel about your contact with your son/daughter.

- I wish we had more contact than we usually have
- I am happy with the contact we usually have
- I wish we had less contact than we usually have

Please select one most important things that you miss the most when you are away from your son/daughter?

- Knowing he/she is okay
- Sharing jokes/banter
- Getting/Providing help (money/household/childcare etc)
- Getting/Providing emotional support
- Talking about daily activities
- Doing activities together
- Nothing much
- His/her presence
- Other _____

Please tell us more about how you and your son/daughter maintain relationship with each other when you are apart? How do you use current technologies (phone, instant messenger, emails etc) to contact each other?

Can you think of any other way that you would like to connect to your son/daughter? Can you suggest what it may be?

10.6 Debriefing sheet

Thank you for taking part in this study. This study was to understand how parents use technology to connect with their adult children. How much contact do people desire in comparison to how much contact they actually have and how that relates to the closeness in their relationship.

Many people live far from their family however maintain contact using information and communication technologies. Research shows that people desire staying in touch with the loved ones even when physically separated. With the help of technology, it is now possible to feel some form of closeness and connectedness for example using instant messaging, SMS, telephone, video chat, emails.

How parents that live away from their adult children, use these technologies to maintain contact is not studied thoroughly. How often they contact each other v/s how much contact they desire is not known. Therefore, my research investigates how people maintain contact with their adult children when living away.

Thank you again for taking part in this study. If you have any further questions or would like to participate in any further studies, please get in touch with the researcher.

Contact details
Researcher: Bhagy Patil.
Email: b.patil@bath.ac.uk

11 Appendix: D

11.1 Ethics form for ConnectJewellery study

Department of Psychology Ethical Approval Form for STAFF

STAFF ☐ PhD STUDENT ■	
Title of Project (max 15 words)	
Name of applicant(s)	Bhagyashree Patil
Contact email for applicant(s)	Bp397@bath.ac.uk
Name of supervisor or lead researcher (for PhD research)	Dr. Jeff Gavin Dr. Danae Stanton-Fraser
Contact email for supervisor	j.gavin@bath.ac.uk
Proposed start date:	10/11/2016
Date of this application:	25/10/2016
Funding body (if relevant)	

PREVIOUS APPROVAL

1. Has this proposal had (or is it awaiting) ethical approval from anywhere else?

YES: Approved	YES: Awaiting approval	NO: not applicable
☐	☐	■

If you answered YES: Please state which ethics body, you received (or are awaiting) Ethical Approval

from: ----------

N.B. If you have already received ethical approval from another body please attach a copy of your ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

NHS BASED PROJECTS

2. If your proposed project is based in the NHS, does it require:

	Yes: Approved	Yes: Awaiting approval	No: not applicable
a. Full NHS ethical approval?	☐	☐	■
b. Research and Development approval?	☐	☐	■

If you have already received ethical approval please attach a copy of your NHS ethics approval letter and one copy of the approved ethics application, as we will need to see these to grant approval.

NOW GO STRAIGHT TO QUESTION No. 19

N.B. If you are awaiting full NHS ethical approval or R&D approval. Please refer to the guidance on how to proceed.

DESCRIPTION OF RESEARCH

Please provide all further information under the following headings in the boxes provided. Please refer to the guidance document for advice on how to fill in each section.

36. Background and aims of the research (maximum 300 words)

Many people live far from their family for at least some part of their lives. Distant relationships between families are common as children move away from family for a variety of reasons such as studying, finding work or simply growing up and moving away to start independent lives. People use traditional information and communication technologies (ICT) such as telephone, emails, and instant messenger to maintain contact. Most available technologies however focus on the transmission of explicit information, which neglects the emotional and subtle communication so typical for close relationships.

In our research we explore how expressive and awareness technologies using IoT may support the distant parent- adult children relationship. Communication can create a sense of connectedness or feeling of being in touch; in awareness systems this may be more important than the content of the communication (Rettie, 2003). We use connectedness and closeness as main variables to evaluate our proposed designs to support parent-adult children relationships. In this study we designed two way of supporting connectedness,

1. Via wearable Jewellery called '*Connect Jewellery'* and
2. A virtual button to send "Thinking of you" messages called '*Connect Text'*

The first, called '*Connect Jewellery'*, uses Internet of things (IoT) Jewellery such as rings and bracelets to send subtle messages of "thinking of you" to one another in vibro-tactile format. This is to support connectedness and closeness between parents and their adult children. The second system called '*Connect Text*' sends the same messages in the form of SMS on mobile phone. The aim is to understand if and how connectedness created via IoT wearables using vibro-tactile sensations compares to messages received via screen-based technology such as mobile phones. There are three hypotheses:
H1: *Connect Jewellery* and *Connect Text* will support better connectedness than regular contact using traditional ICT.
H2: *Connect Jewellery* will support better connectedness than *Connect Text* on mobile phones.
H3: Connectedness will positively correlate to closeness in relationship.

37. Who will be recruited to participate in the research?
All the participants will be over 18 years of age. Participants will be an approximately of 12 pairs of parents and their adult children living in different cities (who consider themselves in a distant relationship). They are expected to be fairly regularly in touch contacting minimum once a week via some medium.

38. How many participants will be recruited?

The study will have total 12 pairs of parent and their adult children as participants. Therefore the study will have total of 24 participants.

39. How will participants be recruited?

Participants will be recruited by posting advertisements on online noticeboards. Advertisements of will also be posted around University of Bath campus.

40. Are there any potential participants who will be excluded? If so, what are the exclusion criteria?
Participants under 18 years of age will be excluded. Also, participants who do not own a smartphone will be excluded. The dyads need to be living apart from each other. They will need to have some contact with each other during the week. They will need to speak English, Hindi or Marathi fluently.

41. Where will the research take place?
The study is conducted 'in the wild' therefore the location will be wherever participants live, travel or work.

42. How will informed consent be obtained from all participants or their parents/guardians prior to individuals entering the study?

Participants will be given an information sheet to read prior to the study, after which they will be given the opportunity to ask questions about the study and then asked to sign a consent form. Two copies of the consent form will be obtained, one of which will be given to participant to take home and the researcher will keep another. These copies will be kept separate from the research data. The copies of these documents are attached.

43. Will the study actively involve deceiving the participants?

No. There is no deception involved in this study.

44. Will participants be made aware they can drop out of the research study at any time without having to give a reason for doing so?

Yes. Both participants can drop out from the study at any time they want. If one of the participants wants to drop out the study then he/she will be advised to contact the researcher. The researcher will then withdraw the pair participation from the study. The other partner will be informed that the study is stopped due to technical difficulties therefore the unilateral withdrawal will not cause problems in the relationship.

45. Outline the design of the research study and list the procedures to which the participants will be subjected, how much time (roughly) it will take for participants to take part in the study, any questionnaires administered and an interview schedule. (maximum 300 words)

The purpose of the study is to explore the effectiveness of two technological systems called "*Connect Jewellery" and "Connect Text"* in long-distance family relationships. The *Connect Jewellery* consists of a ring/bracelet that will be worn by all participants for the duration of the study. This Jewellery is connected to the virtual button on their study partners' mobile phone and vice versa. Pressing the button results into signalling the study partners' Jewellery. *Connect Text* works similar to Connect Jewellery however pressing the virtual button results in sending "thinking of you" text messages to mobile phones of the study partner instead of signalling the Jewellery.

The main study will run for 6 weeks and will be divided into two main phases. Following are the steps taken by participants at each phase,

1. Participants will be asked to fill in two questionnaires at the beginning of the study i.e. before phase one. Participants will be asked to choose a number from a random number pot and if the number is even, they will be given *Connect Jewellery* for phase 1 and *Connect Text* for phase 2 and if the number is odd, they will be given *Connect Text* for phase 1 and *Connect Jewellery* for phase 2.
2. Phase 1 (Week 1-2) will consist of both participants using either of the *Connect* systems ('*Connect Jewellery'* or '*Connect Text*'). They will use that system for two weeks and at the end of each week they will be asked to fill in a five-minute questionnaire via email.
3. Phase 2 (Week 3-4) will consist of using the other *Connect* system (e.g. if they used *Connect Jewellery* in first phase, they will stop using that and instead use the *Connect Text* in this phase.) At the end of each week they will be asked to fill in a five-minute

questionnaire via email.

4. At the end of the phase two (fourth week) they will stop using that *Connect* system and uninstall all the apps from their mobile phones and return Ringly Jewellery provided to them. They will be invited to attend an interview either via telephone or Skype, which may take up to 30 minutes.
5. One week after the phase two (end of fifth week), they will be asked to fill up the final five-minute questionnaire via email.

46. Describe potential risks to participants (physical, psychological, legal, social) arising from these procedures.

There are no known risks to participants.

47. How will participants be debriefed?

All participants will be given a debriefing sheet consisting of information about the study, the kind of data we are collecting and how it will be stored and used. This will also be communicated verbally.

48. How will confidentiality and security of personal data relating to your participants be maintained?

Participants will be informed about the type of data collected. They will be assigned random identifier, which will be used to store all their data to make sure their identity is made anonymous and cannot be traced back to the individuals. The data will be stored securely on the university network drive. It will be made clear to the participant that the data might be published to present results after it is made anonymous.

49. Will the participants be audio-taped or video-taped?

The semi-structured interviews conducted will be audio recorded with the consent of the participants.

50. Is any reimbursement of expenses or other payment to be made to participants?

Participants will be reimbursed for the return shipping charges of the equipment- Ringly Jewellery. They will be reimbursed for any mobile text charges that occurred because of this study.

51. Any other relevant information?

Participants will be advised to contact the researcher if they have any queries or problems during the study and the constant support throughout the study will be provided.

52. Checklist: have you attached?

	YES	NO	N/A
Evidence of ethical approval from another body	☐	☐	■
Information sheets	■	☐	☐
Consent forms	■	☐	☐
Debrief sheets	■	☐	☐
Interview schedules	■	☐	☐
Questionnaire measures	■	☐	☐

Keep in mind that if any of the above information is missing, your application will be returned to you without a decision.

Please submit **two hard copies** of this form, including all attachments, to the designated ethics essay box in the department of Psychology foyer in 2 South across from the main office.

Please note that failure to include any relevant section or signature may result in your form being rejected.

Signature of applicant	Print Name Bhagyashree Patil	Date 01/11/2016

By signing and submitting the form, you are agreeing with the following statement:
'I am familiar with the BPS guidelines for ethical practices in psychology research and I have discussed the ethical aspects of the proposed project with my supervisor(s) and/or the other researchers involved in the project.'

Signature of lead researcher or supervisor (if different from applicant)	Print Name	Date

By signing you are agreeing that you take joint responsibility for the application and conduct of the research.

11.2 Information Sheet for *ConnectJewellery* study

Study Title: Evaluation of *"Connect"* systems.

Thank you for agreeing to take part in this study; which explores the effectiveness of two technological systems called "*Connect Jewellery" and "Connect Text"* in long-distance family relationships. The purpose of this study is to understand how both the *Connect* systems may support parent-adult child relationships that live away from each other. In this information sheet, your study partner refers to the person (either your adult child or your parent) who is willing to participate in this study with you.

The study will involve

- Using Jewellery called *Connect Jewellery* for two weeks and *Connect Text* for the other two weeks.
- Filling in a short two-minute questionnaire two times a week.
- Attending a telephone/Skype interview after fourth week of the study.

The *Connect* systems are intended to provide additional communication/signalling channel to create subtle connection between parents and their adult children. We are interested to see how both *Connect* systems are integrated in your daily communication routine with your study partner. At the end of each week you will be asked to fill in a five-minute questionnaire via email. Following is the description of both the systems,

1. ***Connect Jewellery*:**

The *Connect Jewellery* contains either a ring or bracelet that will be given to both you and your study partner. You both will be asked to install a mobile app on your phones that will make a small virtual button to appear on your mobile screen. This virtual button is connected to your partners' Jewellery and vice a versa. Pressing of the virtual buttons on your mobile screen will result in signalling your study partners' Jewellery. These signals will make their ring/bracelet vibrate and a small light to be flashed. You are free to use the system however you like.

How the Connect Jewellery works:

The system uses the Ringly Jewellery, which consists of either a smart ring or a bracelet that is connected to your mobile phone via Bluetooth. It is originally designed to notify you of important messages/emails received on your mobile however for this study, we have set it up to signal when your study partner presses the virtual button on their mobile. We will also set up a virtual button on your mobile phone, which you can press to signal your study partners' Jewellery. For the system to work, we will need to install and setup two apps on your mobile phones called Ringly and Flic. The researcher will verbally guide you through configuring the entire setup of this system.

2. ***Connect Text*:**

The *Connect Text* works in a similar way to the *Connect Jewellery*. The difference is that instead of sending signals to the Jewellery of your study partner, the signal is sent as text on their mobile phone and vice a versa. When you press the virtual button on your mobile phone, a "Thinking of you" SMS is sent to your study partners' mobile phone. The setup involves setting up a 'Flic' app on your mobile phone. The researcher will verbally guide you through the process of setting up the system.

Duration and steps:

The main study will run for 6 weeks, and will be divided into two main phases. Following are the steps that will be taken at each phase,

1. You will be asked to fill in two questionnaires at the beginning of the study i.e. before phase 1. You will be assigned a number generated via random number generator system and if the number is even you will be given *Connect Jewellery* for phase 1 and *Connect Text* for phase 2 and if the number is odd you will be given *Connect Text* for phase 1 and *Connect Jewellery* for phase 2.
2. Phase 1 (Week 1-2) will consist of you using either of the *Connect* systems ('*Connect Jewellery'* or '*Connect Text*') depending on the random number you get. You will use the system for two weeks and at the end of each week you will be asked to fill in a five-minute questionnaire via email.
3. Phase 2 (Week 3-4) will consist of using the other *Connect* system (e.g. if you used *Connect Jewellery* in first phase, you will stop using that and instead use the *Connect Text* in this phase.) At the end of each week you will be asked to fill in a five-minute questionnaire via email.
4. At the end of the phase two (fourth week) you will stop using the *Connect* system and uninstall all the apps from your mobile phones and return Ringly Jewellery provided to you. You will be invited to attend an interview either via telephone or Skype that will be audio recorded.
5. One week after the phase two (end of fifth week), you will be asked to fill up the final five-minute questionnaire.

The researcher will verbally guide you through what needs to be done at each stage. Please feel free to contact the researcher and ask any questions at any time during the study. The details of the researcher are at the end of this document.

You will be given a pre-paid package to return all the material. If your network provider charges for sending/receiving mobile text for this study, we will reimburse those to you. Please note that it might take several seconds or minutes for the ring/bracelet to vibrate after you or your study partner presses their virtual button. You may continue to use other ways to communicate with your study partner, as you would normally do so.

Your privacy

At all times during this study your anonymity will be preserved. Your information will be stored against a random identifier rather than your name or details. Your name will only exist on the consent form, which will not be digitized and will be stored securely in a locked cupboard, according to University confidentiality procedures.

Your audio interview will only be available to the researcher and their supervisors and will also be kept secure. The results may be published in anonymous form.

Voluntary participation:

Your participation is completely voluntary. Participating in this study does not involve any risks outside of those encountered in your everyday life. You have the right to withdraw from the study at any time without consequence. If you do want to withdraw from the study, we would request you to contact researcher immediately.

Contact details

Researcher: Bhagy Patil. Email: b.patil@bath.ac.uk

11.3 Consent form

Study Title: Evaluation of *Connect* systems.

Please read the information sheet and consent form carefully before you decide to participate in this study.

Agreement

By signing this sheet, I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. I understand that my participation is voluntary, and I have right to withdraw any time during the study. I understand that my data collected in this study will be used in scientific publications in anonymized form. I will return the material provided to me at the end of this study. I voluntarily agree to participate in the procedure and have received a copy of this description and the information sheet.

Name of Participant Date Signature

Email

Please contact the researcher if you need any support regarding study, experience any problems with equipment or have any queries.

Researcher:
Bhagyashree (Bhagy) Patil,
Department of Psychology, University of Bath, Bath, BA2 7AY.
Email: **b.patil@bath.ac.uk.**

11.4 Pre-study questionnaire

Demographic Questions
Directions: For the below questions, select the option that best answers the question.

1. Are you male or female?

- ❍ Male
- ❍ Female
- ❍ Prefer not to say

2. What is your age?

- ❍ 18 - 24
- ❍ 25 - 29
- ❍ 30 - 34
- ❍ 35 - 44
- ❍ 45 - 54
- ❍ 55 - 64
- ❍ 65 - 74
- ❍ 75 - 84
- ❍ 85 or older

3. Which country are you from?

[List of countries in drop down box]

4. Which would you describe as your ethnic origin?

- ❍ Caucasian
- ❍ Latino/Hispanic
- ❍ Middle Eastern
- ❍ African
- ❍ Caribbean
- ❍ South Asian
- ❍ East Asian
- ❍ Mixed
- ❍ Other

5. Which of the following best describes your current occupation?

- ❍ Full time student
- ❍ In employment (part or full time)
- ❍ Looking after the home / family
- ❍ Not eligible for employment
- ❍ Retired
- ❍ Self-employed
- ❍ Unemployed

6. Please state your role

☐ Parent participant ☐ Adult child participant

Communication competence of the person

7. Which mobile phone do you use?

❍ Smart phone (Android, iPhone, Windows)
❍ Older generation mobile Phone (For example flip-phone, old Nokia, old Sony Ericsson)
❍ I don't use a mobile phone

8. Please check the box next to all the technologies that you use regularly (at least once a month) to communicate with other people. (Please choose as many as you use every month)

❑ Calling via Land line telephone
❑ Calling via Mobile phone
❑ Instant messaging via Mobile phone or Computer (e.g. WhatsApp, Viber, Facebook messenger, IMO, Telegram, Snapchat)
❑ Text messaging (SMS/MMS)
❑ Video & audio calls through programs such as Skype, FaceTime, ooVoo, or Tango
❑ Audio only calls through programs such as Skype, FaceTime, ooVoo, or Tango
❑ Email (via computer or smart phone)
❑ Social networking websites such as Facebook, Twitter, Instagram, Flickr, Google+, LinkedIn or other similar sites
❑ File sharing such as Dropbox, Google Docs, etc. (don't check this box if you only file share with yourself, you must use it to file share with other people).
❑ Sharing videos online, such as through YouTube, Vimeo, Dailymotion, etc.
❑ Family mobile apps for location sharing
❑ Shared online calendar such as Google Calendar, Cozi Family Organizer, Wiggio, or Keep and Share Calendar (don't check this box if you only use the calendar with yourself, you must use it to communicate with other people)
❑ Letters/ Cards
❑ Other 1 _____
❑ Other 2 _____

Multiple questions Connectedness Scale
Developed from Rettie (2003) and Licoppe (2004)

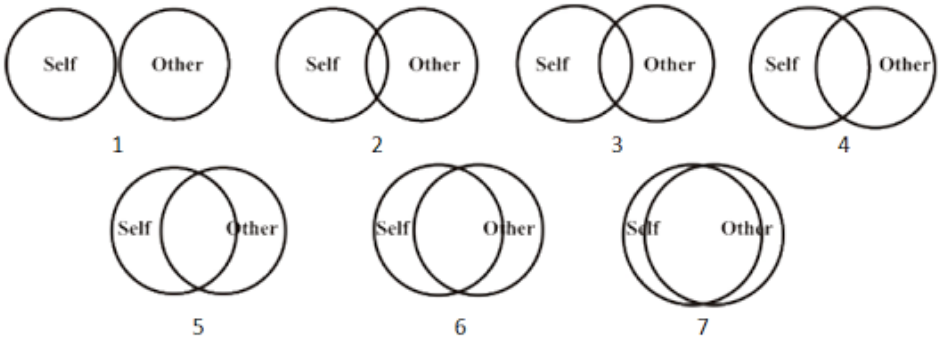
Directions: Indicate how frequently your mother/father/son/daughter engages in the following behaviors by selecting the corresponding number.

Strongly agree- strongly disagree

1. In the past week my mother/father/son/daughter has contacted me mainly just to exchange pleasantries (hello's, goodbye's).
2. In the past one week my mother/father/son/daughter has called and/or messaged me just to maintain contact.
3. In the past one week my mother/father/son/daughter has contacted me just to let me know s(he) is thinking of me.
4. In the past one week my mother/father/son/daughter has contacted me just to keep in touch.
5. In the past one week my mother/father/son/daughter has contacted me throughout the day about insignificant things happening in his/her day.
6. In the past one week my mother/father/son/daughter has tried to maintain a sense of connection with me.

IOS Closeness scale
(Aron, Aron & Smollan, 1992)

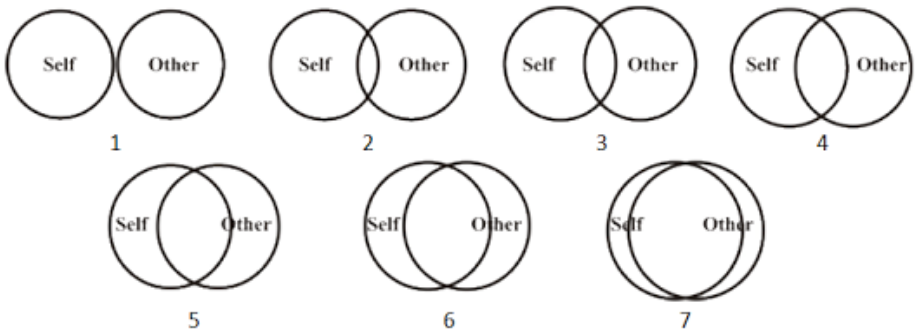
Please select the picture, which best describes how close you felt to your mother/father/son/daughter in the last week?



11.5 **Weekly questionnaire**

Multiple questions Connectedness Scale
Developed from Rettie (2003) and Licoppe (2004)
Directions: Indicate how frequently your mother/father/son/daughter engages in the following behaviours by selecting the corresponding number. (Strongly agree-strongly disagree)
1. In the past week my mother/father/son/daughter has contacted me mainly just to exchange pleasantries (hello's, goodbye's).
2. In the past one week my mother/father/son/daughter has called and/or messaged me just to maintain contact.
3. In the past one week my mother/father/son/daughter has contacted me just to let me know s(he) is thinking of me.
4. In the past one week my mother/father/son/daughter has contacted me just to keep in touch.
5. In the past one week my mother/father/son/daughter has contacted me throughout the day about insignificant things happening in his/her day.
6. In the past one week my mother/father/son/daughter has tried to maintain a sense of connection with me.

IOS Closeness scale
(Aron, Aron & Smollan, 1992)
Please select the picture, which best describes how close you felt to your mother/father/son/daughter in the last week?



- Compared with the "normal" amount of time you usually spend communicating with your study partner, how typical were the past few days? (Choose one) Typical Not-typical
- If this was not typical for you, please can you briefly explain why?
- Please tell us how you felt about your contact with your study partner over the past week? Was anything different/unusual? How did you feel about the contact between you? How did your contact make you feel about your relationship?

11.6 ABCCT scales and questions.

<X> is the relationship and <M> is the medium being investigated. Participant should respond on a 5 point Likert-type frequency scale (never, rarely, sometimes, usually, or always)

Emotional expressiveness:

Communicating with <X> using <M>helps me tell how is feeling that day.
Communicating with<X> using <M> helps me let know how I am feeling.
Communicating with <X> using <M>helps me see how much cares about me

Engagement and playfulness:

I feel that contact with me using <M> is engaging for <X>
I am excited about using<M> with <X>
I have fun with <X> while using<M>

Presence-In-Absence:

Communicating with <X> using <M> helps me feel closer to <X>
After we are done communicating, I still keep thinking back to something <X> shared using<M>
Communicating with <X> using helps me feel more connected to <M>.

Opportunity for Social Support:

Communicating with <X> using <M> helps me provide with social support.
<X> makes me feel special in our contact using<M>
Communicating with me using helps <X> be there for me when I need them.
Communicating with <X> using <M> when I am having a bad day helps me feel better.
Communicating with <X> using <M> helps me feel less worried about something.

Unwanted Obligations:

I worry that <X> feels obligated to contact me using <M>
I have to talk to <X> using <M> even if I don't want to.
I feel guilty if I don't answer a contact <X> makes using <M>
I have to answer when <X> tries to contact me using <M> even if I don't want to.

Unmet Expectations:

I feel sad when <X> isn't around when I try to contact using <M>
I feel sad when <X> takes too long to respond when I try to contact using <M>.
I worry that I am not meeting <X>'s expectations for our contact using <M>
I feel sad when <X> doesn't pay enough attention to me when we use <M>.

Threat to Privacy:

I worry that <X> might learn something using <M> that I want to keep secret.
I worry about my privacy while <X> and I are using <M> together
I worry that others may overhear or see something that <X> and I share using<M>

I worry that I am violating <X>'s privacy during our contact using <M>

11.7 Semi-structure interview prompts.

I am going to ask you few questions about your communication with ___ and then some questions about the system.

General communication questions

1. What are some of the things you miss if any, when you were apart from your partner?
2. Can you tell me a bit more about your communication routine?
   2.1. You said in your questionnaire that you use ____
      a. Which one do you use the most? Which one the second most?
      b. How frequently do you use it?
      c. Who initiates the contact?
3. What are the main reasons for using these methods to communicate with your study partner?
4. How does your communication with your study partner ___ compare to communication you have with your other children/parent?
5. Is there anything that you would like to change the way you communicate with your study partner? i.e. in terms of what technologies you use, not necessarily what you say
6. How do you usually maintain connection with your study partner?
7. How do you usually maintain closeness with your study partner?

Connect Jewellery Questions

8. Can you start by telling me your general thoughts about the Jewellery system?
   8.1. What makes you say that?
9. Could you describe how you used it?
   9.1. How many times? (Where? When? How? What situations?)
10. Did you use it at the same time as your partner?
11. How did you use Jewellery alongside the other communication technologies you use?
    11.1. Which ones? Are the things you did usually done with one of the others?

Design features

12. What did you think about the design of the Jewellery?
13. What did you think about the light and the vibration?
14. What did you think about pressing the button to send signals?

Feelings

15. How did you feel using the Jewellery to connect with your study partner?
    15.1. How did you feel when you received signals?
    15.2. How did you feel sending signals to your study partner?

16. Did you feel compelled to send signals to them?
    16.1. Please explain / what are your reasons?
17. Do you think the system impacted on your communication routine? How?
18. Did system have an impact on your relationship? How?
    18.1. Did it become routine to use it?

Other

19. Is there anything you would change or improve about Jewellery or the system in general?
    19.1. If so, what?
20. Can you think of any other way of using it?
21. What are your thoughts about continuing to use Jewellery to connect to one another?
22. Did you experience any problems with the system?
    22.1. Did you encounter any technical issues?

Questions about Connect Text:

23. Can you start by telling me your general thoughts about the text only system?
    23.1. What makes you say that?
24. Which of these two did you prefer using?
    24.1. Why? What makes you say that?
25. Was the experience of using connected text similar or different than Jewellery?
    25.1. How? Why? What was different?
    25.2. How about times and places? (Where? When? How? What situations?)

Feelings

26. How did you feel sending/receiving 'thinking of you' text to connect with your study partner?
27. Did you feel compelled to reply to your partner?
    27.1. Please explain / what are your reasons?
28. What did you think about the content of the message?
29. Would you have liked to send any other content? What text?
30. What are your thoughts about continuing to use the text system to connect to one another?

That's everything, thank you very much for your time. Do you have any other comments or things you would like to say?

11.8 Debriefing sheet

Study Title: Evaluation of *Connect* systems.

Thank you for taking part in this study. This study was to understand how people use the *Connect* systems and how they integrate in daily communication habits.
Many people live far from their family at least for some part of their lives. Distant relationships between families are common as children move away from family for variety of reasons such as studying, finding work or simply growing up and moving away to start independent lives. Although living away, studies show that parent and their adult children maintain close relationships throughout their lives. People use traditional information and communication technologies (ICT) such as telephone, emails, and instant messenger to maintain contact. Most available technologies however focus on the transmission of explicit information, which neglects the emotional and subtle communication so typical for close relationships. Also, research shows that communication alone is not sufficient in feeling the intimacy in distant relationships.
In our research we explore how expressive technologies may support the distant parent- adult children relationship. We are interested to investigate how new, connected; simple to use technology can create connectedness and bring closeness in distant relationships. We designed two way of supporting connectedness, via wearable Jewellery called '*Connect Jewellery'* and '*Connect Text'.* The aim is to understand if and how connectedness is created via wearable devices using vibro-tactile sensations compared to messages received via screen-based technology such as mobile phones and whether this increase feeling of closeness.
Thank you again for taking part in this study. If you have any further questions, please get in touch with the researcher.

Contact details:
Researcher: Bhagy Patil.
Email: b.patil@bath.ac.uk

11.9 Advert for call for participants

11.10 Graphs for interaction data between pairs of participants

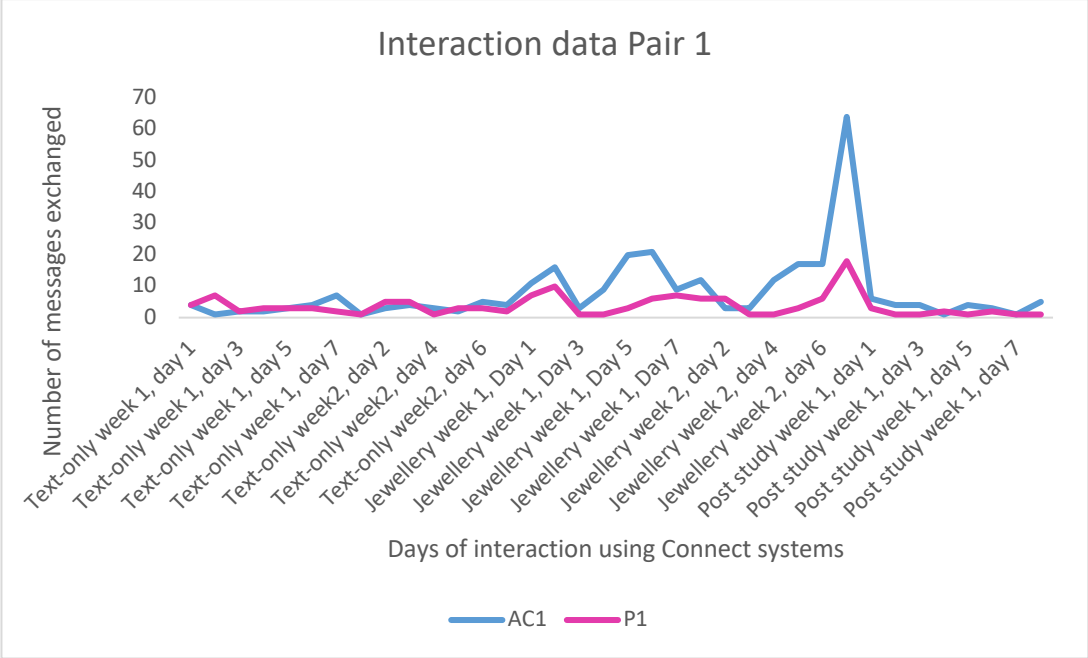


Figure 36. Interaction data Pair 1

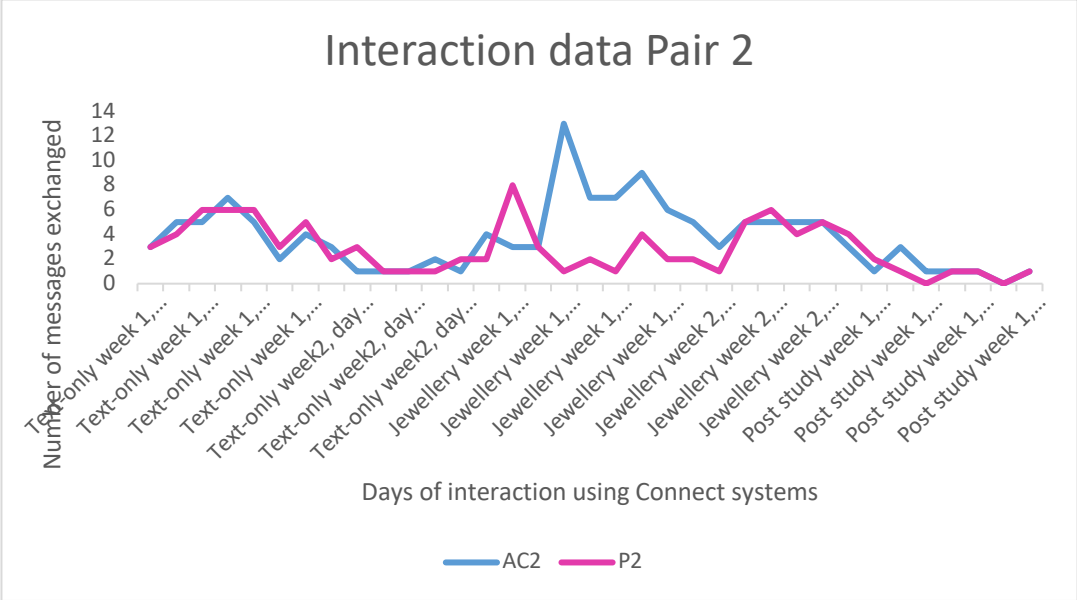


Figure 37. Interaction data Pair 2

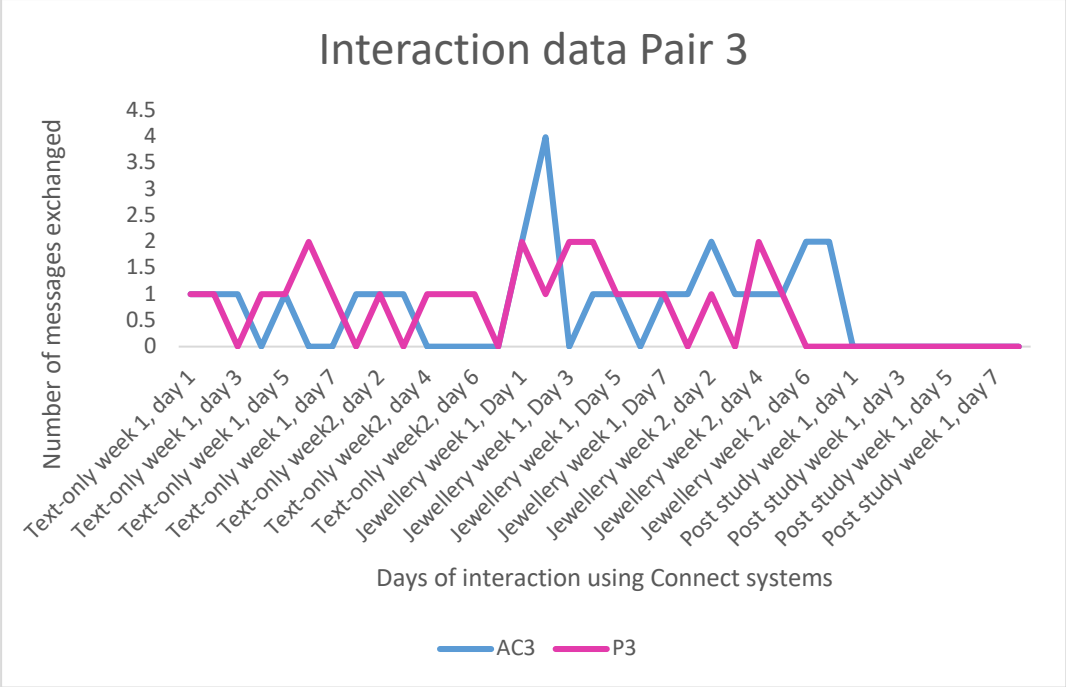


Figure 38. Interaction data Pair 3

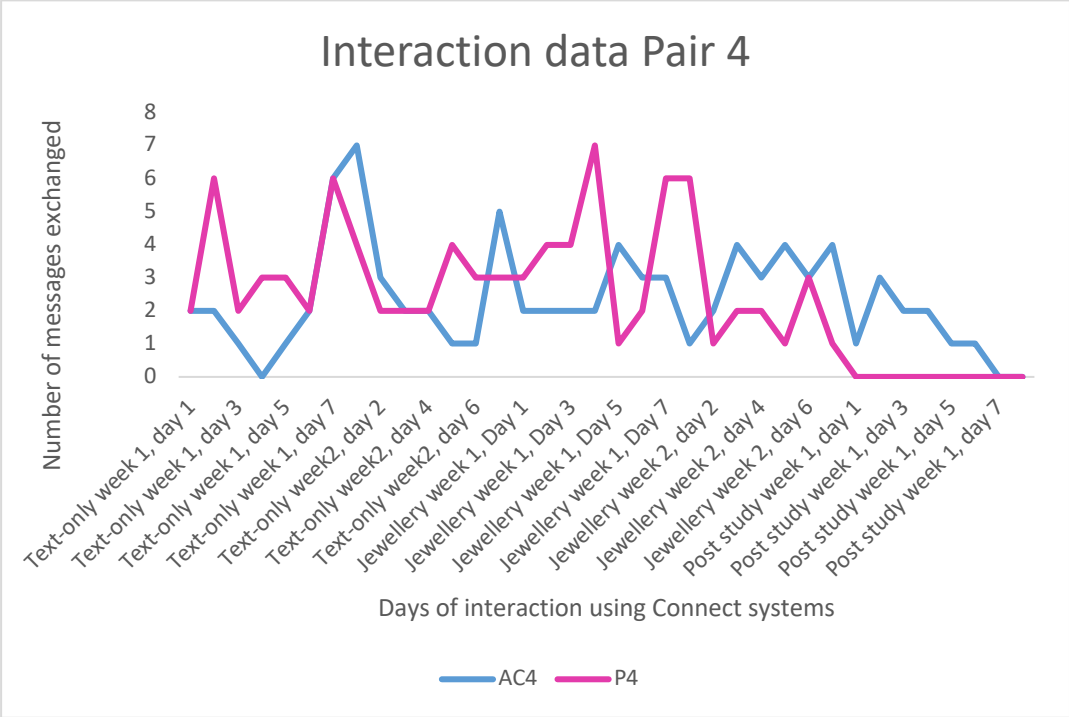


Figure 39. Interaction data Pair 4

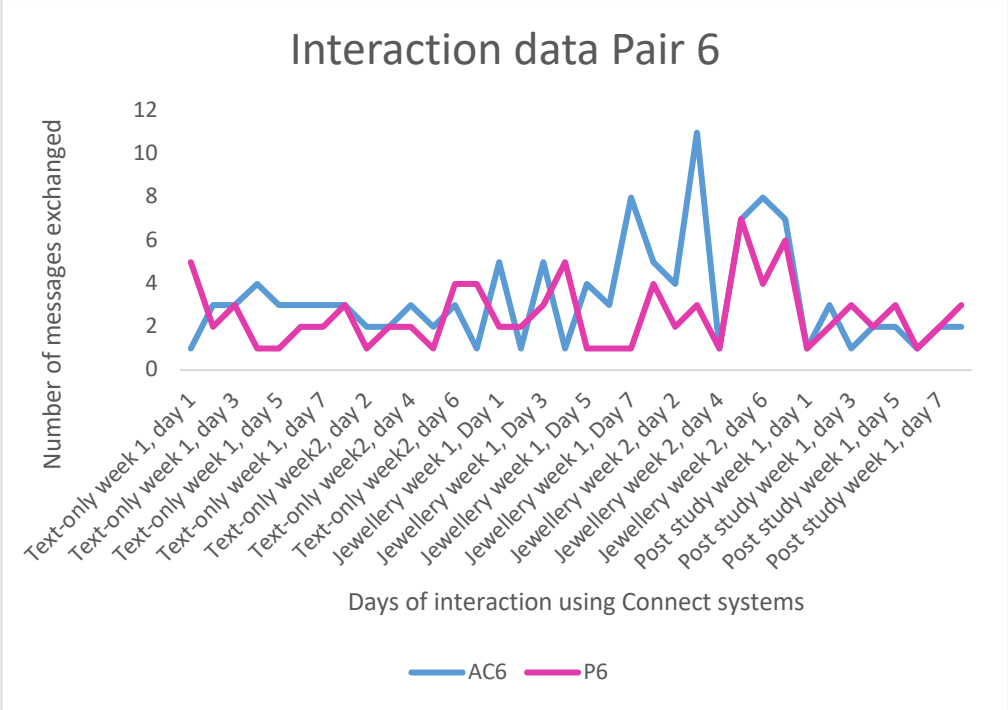


Figure 40. Interaction data Pair 6

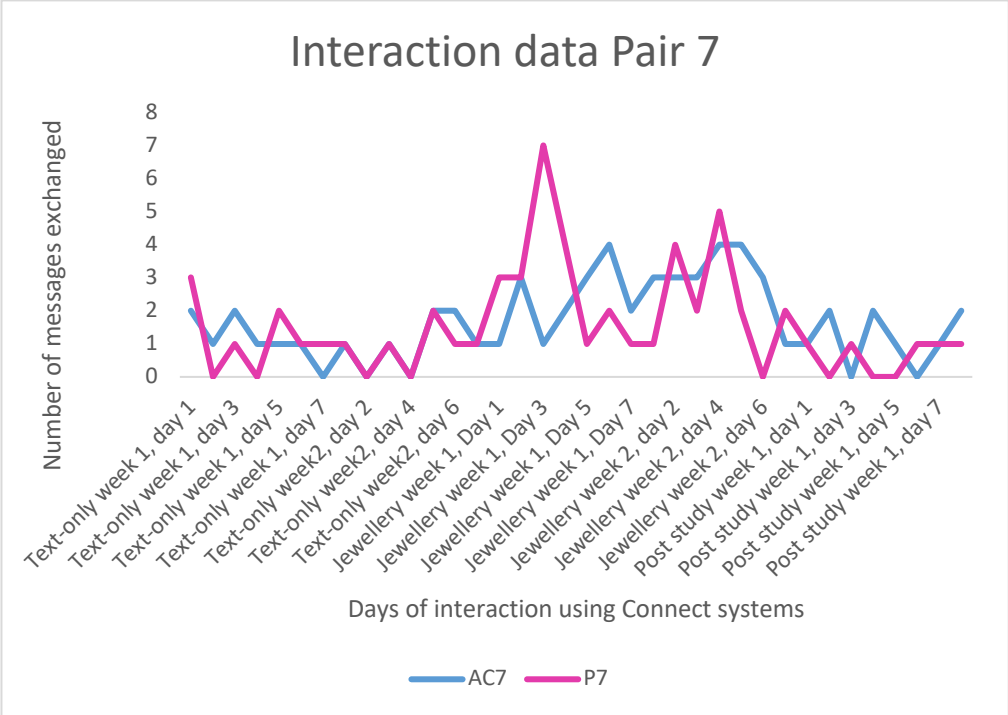


Figure 41. Interaction data Pair 7

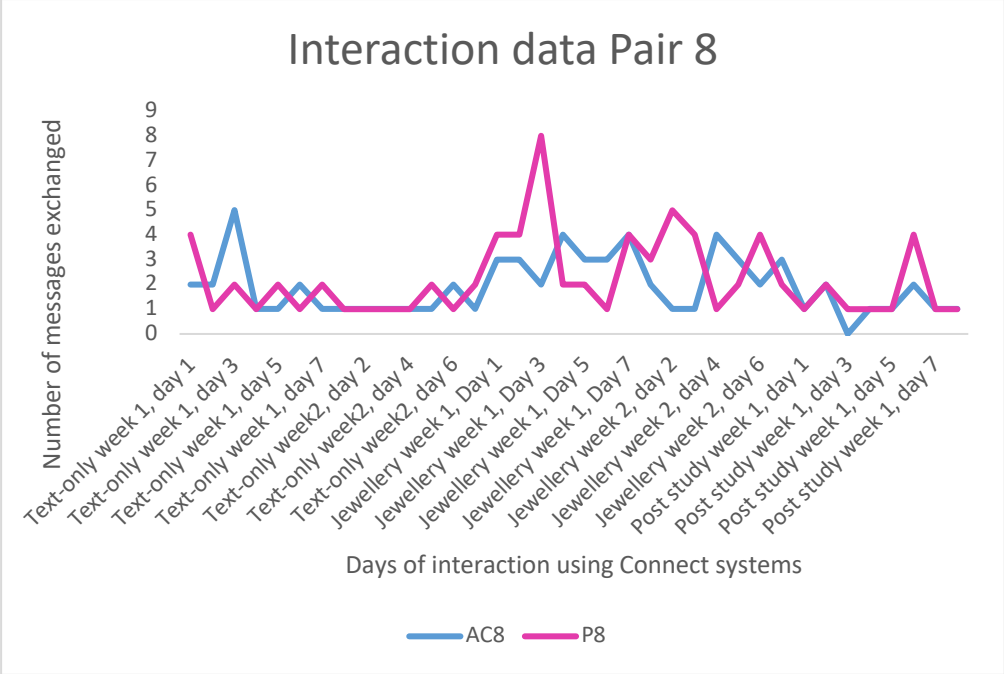


Figure 42. Interaction data Pair 8

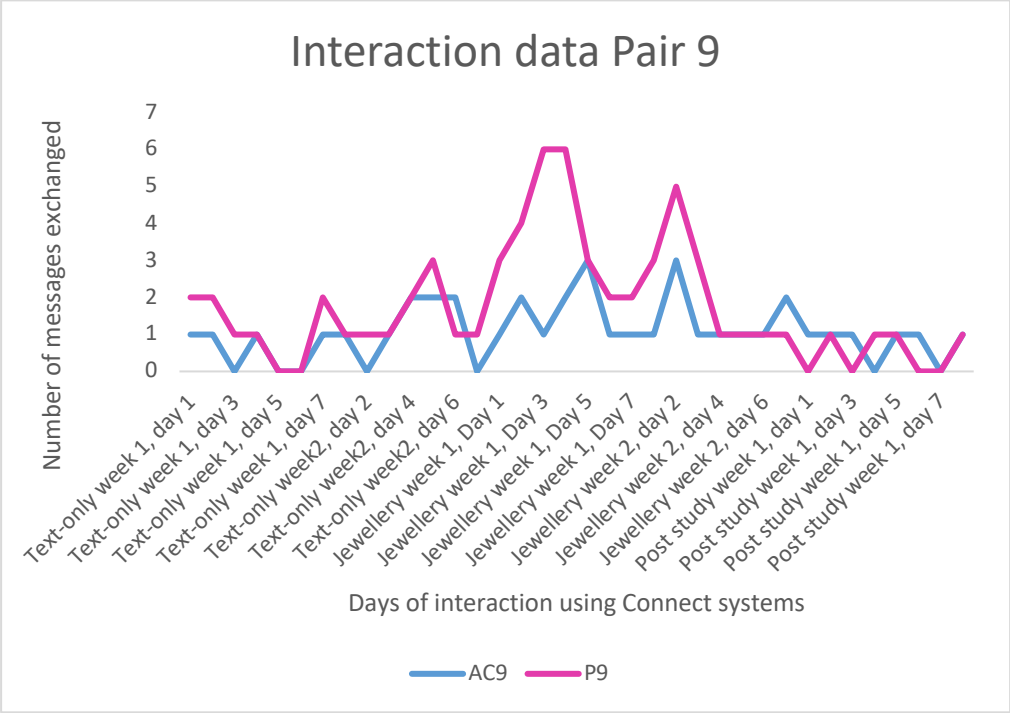


Figure 43. Interaction data Pair 9